CATÓLICA
ESCOLA DAS ARTES
PORTO

CONSERVATION OF URBAN ART

COATINGS AND GREEN CLEANING METHODS FOR VANDALIZED URBAN ART MURALS IN ITALY AND PORTUGAL

Dissertation presented to Universidade Católica Portuguesa
to obtain the degree of Master in Conservation and Restoration in Cultural Heritage

Margarida Santos Jesus de Castro

Porto | 2020

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Integrated Heritage

Margarida Santos Jesus de Castro

Dissertation under the supervision of
Doctor Patrícia Moreira

And co-supervision of
Doctor Eduarda Vieira
Doctor Andrea Macchia

Porto | 2020

To my grandmother, my mother, my father and my sister.

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ABSTRACT

This research focuses on methodologies for intervention in urban art murals made with aerosol paints. The dissertation is divided into two blocks of research that complement each other based on the YOCOCU's mural art conservation experience.

The first block reports the research on protective coatings, in order to prevent the action of vandalism in aerosol inks, such as the accelerated deterioration of the original constituents in a mural work. Coatings selected for tests were those usually used for built heritage and considered anti-graffiti. To evaluate the performance of these coatings on various paints, analytical tests such as OM, SEM/EDS and colorimetric analyses have been performed. SEM/EDS and OM results showed that vandalized inks with coatings didn't penetrate into the chromatic layers or were altered with the vandalism simulation. Colorimetric values registration in paints with coatings over four months however shows alterations in all of the selected paints.

The second block focuses on solutions for cleaning murals that have been subjected to vandalism. A green methodology was tested where combinations of solvents of low toxicity were chosen. These were selected under the criteria of being not harmful to the artwork, the operator and the environment. The mixtures tested were designed under the J.P. Teas system, with control of the forces of dispersion (fd), polar (fp) and hydrogen (fh), to help define the best method of intervention in the removal of vandalism without damaging the underlying chromatic layers. Results have shown that several solvent mixtures are needed, for specific scenarios depending on the thickness of the vandalic layer, binder of the ink and the operator control.

The best protective coating and solutions were selected within various commercial paints and applied in a case study of an artwork in Porto. "Virtus", a mural by Hazul was selected for case study. This work presented several pathologies, related with the use of spray paint, vandalism, stickers, permanent marker and a burnt area. It also presented other pathologies of physical and biological origin, therefore an intervention was carried out, aiming the stability and the aesthetic integrity of the artwork, while electing green cleaning methodologies and strategies.

Keywords:

mural art, aerosol ink, green solvents, coatings, vandalism, Hazul, Porto.

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LIST OF ACRONYMS

Δδ | Delta

ΔE | Colour Difference as measured by L*a*b* system

2-MeTHF | 2-Methyltetrahydrofuran

BSE | backscattered electron

cm^{-1} | wavenumber energy unit

DBE-LVP | Dibasic esters – low vapor pressure

Fig. Att. | Figure in Attachment

Fig. Appx. | Figure in Appendix

FTIR | Fourier-transform infrared spectroscopy

IBIX | Protect IT 100

IMAR | Antigraffiti I.M.A.R

IVAS AS | Ivas Idromatt

IVAS SP | Ivas Superquarz Plus

mid-IR | Mid-wavelength infrared

MTN 94 | Montana 94

MTN WB | Montana Water Based

OM | Optical Microscope

PPE | Personal Protective Equipment

SEM/EDS | Scanning Electron Microscopy with Energy Dispersive Spectroscopy

TiO_2 | Titanium dioxide

VOCs | Volatile organic compounds

Zn | Zinc

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INTRODUCTION

This dissertation aims to test different solutions for conservation and intervention in urban art murals, including anti-graffiti protective coatings and chemical cleaning of works vandalized with aerosol paints.

Due to is historical development and successive changes over the years, urban art is increasingly present and accepted in society, including communities, artist's circles and within art history. Relating the city landscape and the mural movement as a discussion among conservators-restorers, this research focuses on finding a green framework for preservation, conservation and restoration of urban art murals.

The study was carried out within the Erasmus+ programme established between the Universidade Católica Portuguesa and the Sapienza Università di Roma.

The structure of the dissertation is divided into three chapters: historical contextualization; research about protective coatings and solvent blends for vandalism cleaning; and lastly the case study of a mural, conducted in Porto, Portugal.

The first chapter is dedicated to the historical context and the problem of conservation of urban art murals. It begins with the evolution of current nomenclatures, thought the first tags, pieces, writers, to those in the subways and trains to the city walls. It also discusses the paradigm change that led to the entry of artists in the museum context. The historical origins of urban art, as well as its influence on the rest of the world, and a brief history of the movement in Portugal and Italy, tracking the evolution and mutation along the decades of the 20th century and the first decades of the 21st century, are presented. The last sub-theme of this chapter focuses on the issues in conservation of urban art including, ethical problems faced by conservators.

The second chapter begins with a contextualization of the most recurrent materials in urban art murals, with focus on technical and material aspects. The methodology applied was conducted and guided by the YOCOCU entity (YOuth in COnservation of CUltural Heritage) in Rome, Italy. The preparation of specimens with the selected paints, the study of anti-graffiti protective coatings and the choice of green solvents for the removal of vandalism with aerosol paint, all dully described. Analytic techniques regarding this set of experiments include optical microscope observations, SEM/EDS and colorimetric analyses for the investigation of protective coatings. For the solvent blends study, the J.P. Teas system was implemented as a guide for the control of dispersion (fd), polar (fp) and hydrogen forces (fh) of solvents and to define zones of total or partial potential vandalism removal without damaging the underlying chromatic layers. The data from the experiments was analyzed and dully discussed.

The chapter three of this dissertation concerns the case study. An *in situ* work was selected as a case study for the applicability of the research carried out. The selected artwork "Virtus" by Hazul, dated 2015, integrates the west wall of the building of Escola Artística e Profissional Árvore, in Porto. The identification of the artwork is complemented by formal, stylistic and iconographic description as well as institution's and artist's historical background. The material description based on the analysis of the technique, information collection, optical microscopy observations and FTIR laboratory analysis was done. The conservation state diagnosis was performed by documenting all the pathologies existent in the artwork. Lastly, it is presented the conservation treatment, with a description of the phases and treatments carried out and a brief reflection on preventive conservation measures is presented.

CHAPTER I

HISTORICAL AND ARTISTIC CONTEXTUALISATION OF URBAN ART MURALS

1.1. Definition of Concepts and Historical Evolution of Urban Art

1.1.1. Definition of Graffiti, Street Art and Urban Art concepts.

Travelling through any city it is possible to see in the urban space, artistic manifestations that change and give life to the urban landscape. Contemporary art in the 21st century is constantly changing namely urban art, in a wider context and with various nomenclatures or languages that are now more easily recognized (Abreu, 2017; Kendall: 2017)

Since the early 60s, this artistic current presented its own languages, with the use of commercial materials, first with permanent markers with a thick tip and later with aerosol ink. Artists expressed themselves through simple stylized monochrome writing, the tags[1], essential element in the dissemination of the writer identity[2] through the city (Figure 1). The practice of the writing movement, triggered graffiti, also illegal and born within American underground culture (da Costa: 2016; Kendall: 2017; Dogheria, 2015ª; Castro, 2014).

With the evolution of the movement, artists have sought new expressions and personal styles. They looked for new ways of combining letters, confronting each other in competitions for territory marking. Therefore, first have appeared the throw-ups or "throwies" (diminutive), of stylized writing, with greater technical dexterity than the tags with the use of two colours, yet simple (Figure 2), evolving to enlarged letters in rounded form and filling it a second colour for a rapid filling of a space, sometimes with bubble

Figure 1 – Examples of Tags (ext. de Cooper, 1984, p.14).

Figure 2 – Examples of throw-ups (ext. de Cooper, 1984, p.92).

[1] Tags are the identity, the pseudonym usually accompanied by the street number of the community in which they live. It is registered as the simplest form of typographic writing, executed as quickly as possible. (Dogheria, 2015; Castro, 2014).

[2] Artists are referred to as writers, because of the explicit practice of writing alphabetic characters, a movement called writing. (Dogheria, 2015a).

letters or block letters styles. Pieces appear following the types of graffiti and increasing competition between artists. These become more and more appealing due to the technique implemented, such as the writer's message and artistic expression. Several styles from Eastern Europe, such as toy style, also known as trash style, anti-graff, ignorant style, among others, are based on the nomenclature given to inexperienced writers at the beginning of their career, characterized by decontextualized compositions, sinuous lines and bright colours, purposely executed in opposition to the "photoshopped" murals visible in the urban space (Figure 3). The cholo style of Los Angeles, a writing typology preferred by the graffiti gang is considered an elegant handwriting (Figure 4). With the disappearance of the borderlines due to globalization trought internet sharing, new styles appeared, like the Berlin style (Figure 5) a style with interlaced letters in a complex arrangement covering multiple colours, the *Pixação* from Brazil with lenghty and politicized lettering (Figure 6), the Brooklyn Handstyle where flowered tags predominate and the Broadway Elegant (Figure 7) with the use of large, stitched and unreadable letters (Kendall: 2017; Castleman, 1982 apud Campos: 2016).

Figure 3 – Example of toy style by Lady Latex (ext. of Trash, p.33).

Figure 4 – Example of *cholo* style (ext. of Phillips, p. 58).

Figure 5 – Example of Berlin Style, by Kwest (ext. de Ganz: 2004, p. 68).

Figure 6 – Example of *Pixação* (ext. of The Guardian: 2016).

The practice of graffiti since the beginning of the movement was branded by crews, groups of writers who organized and collaborated in the creation of more complex murals well known the in artistic environment (da Costa: 2016). The crews worked in hierarchy, so any writer who belonged to a certain group would have to win the right to became a group member and to disseminate of their tag and their art. The higher their popularity, the higher would be their position in the hierarchy and greater the probability of being able to paint on the most emblematic walls, for example the Hall of Fame, where only the kings[3] could have access. These walls are continuous walls in open spaces and may or may not be provided by local authorities (Simões: 2013; da Costa: 2016). As the 21st century unfolded, new types of street art entered the underground culture. Street art was an important milestone in the attempt to get closer to the public, who previously did not understand stylized writing, unless they belonged to the movement. Street art includes not only the use of the aerosol paints but have also absorbed the graphic and painting techniques, such as stencil from serigraphy, posters, woodcuts, stickers, outdoor industrial paints, as well as the replacement of the tags[4] by abstract figures, symbols and graphical forms, as seen in Figure 8 (Hughes: 2009; Neves: 2015; Kendall: 2017).

Urban art arises in the institutional context by doing the appropriation of this illegal movement, where the works were funded by various entities, companies, councils, among various benefactors. They were featured by monumental paintings on the building facades, walls or any support given for that purpose, where the temporal conditions, as preparatory, were far from the trend of the 1960s. In this movement the artists presented compositions more accessible to the public, with a coherent figurative language which leads to greater

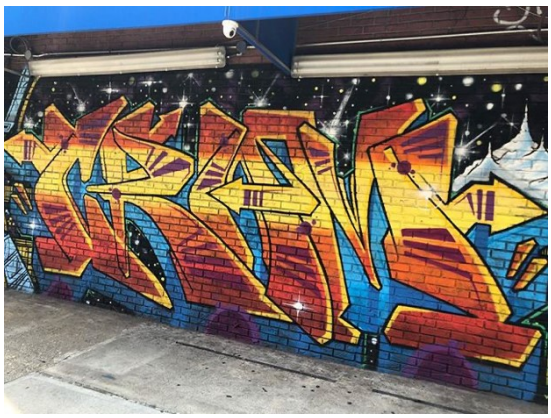

Figure 7 – Example of Broadway Elegant (ext. of Kahn).

Figure 8 – Stickers and Paste Up (photo by M. Castro).

[3] Denomination for writers who stood out from the rest of the crew or the underground community.
[4] Recently one of the most appreciated ways by artists in the diffusion of their pseudonym through tags is the creation of identifying logos, already printed on stickers, where the application process is faster than writing with a marker (Castro, 2014).

affection and acceptance by the public, as seen in Figure 9 (Castro, 2014; Simões, 2013; Neves, 2015)

Figure 9 – Mural painting "Mr.Rooster" of Etam Sainer in Los Angeles, United States of America (ext. de Sainer, 2015).

1.1.2. Historical Evolution of Underground Culture

At the end of the 60s, a contemporary movement emerges that will trigger a new typology of public art at the beginning of the 21st century. This trend emerged within an underground context, in a subculture that appeared in the social quarters of the United States of America being marked by its ephemeral language, produced by young people belonging to a socio-cultural context of transgression in the city (Wacklaweck, 2011, da Costa: 2016).

The graffiti movement has evolved over the years, sometimes called by different designations due to the panoply of writing styles directly connected to the city or place where the practice began, as the graffiti gang, starting in the sixties in Philadelphia and Chicago, and hip-hop graffiti in New York City during the seventies (Waclawek, 2011;

Simões, 2013), and even Joe Austin (2010), determines other names for the movement, such as graffiti art, or aerosol art by Phase 2 (Neves, 2015). This development took place at the end of the II World War and under massive emigrations to North America. From this new society, the 2nd and 3rd generations sought to express the social context surrounding them, crossing the frontier of legality (Kendall: 2017).

Looking back in art history, it seems apparent that this counter-culture, in certain aspects, can be identified with the rupestrian mural paintings, the Roman inscriptions, the muralism of Latin America and Europe in the twenties and thirties, as well as the various sgraffiti of soldiers during the First and Second World War, among others (At War, 2018; Dhogeria, 2015). This human impulse to scrape appears everywhere since the existence of humanity, transcending ethnicity, cultures and places, including complex to simple messages, as for example, only "I was here", indicative of animal essence and human subconscious condition.

Duccio Dogheria (2015) defines modern graffiti as the creative-communicative use of walls. This definition defines the essence of the birth of writing, with markers identifying the pseudonym of an individual. From the first tags identified in cities and which were recognized as catalysts for the movement, one emerges in the context of a shipyard worker, James J. Kilroy, who wrote "Kilroy was here" everywhere he inspected as proof that he was working, and later his writing was also accompanied by a character peering over a wall. This practice was spread among American soldiers all over Europe and became a symbol in peace protests (Castro, 2015). Later, in 1971, writing appears in the urban movement boom, as a writer, TAKI 183 (corresponding to his nickname and street

The New York Times

NEW YORK, FRIDAY, JUL 21, 1971

'Taki 183' Spawns Pen Pals

Taki is a Manhattan teenager who writes his name and his street number everywhere he goes. He says it is something he just has to do.

His TAKI 183 appears in subway stations and inside subway cars all over the city, on walls along Broadway, at Kennedy International Airport, in New Jersey, Connecticut, upstate New York and other places.

He has spawned hundreds of imitators, including Joe 136, BARBARA 62, EEL 159, YANK 135 and LEO 136.

To remove such words, plus the obscenities and other graffiti in subway stations, it cost 80,000 manhours, or about $300,000, in the last year, the Transit Authority estimates.

"I work, I pay taxes too and it doesn't harm anybody," Taki said in an interview, when told of the cost of removing the graffiti.

And he asked: "Why do they go after the little guy? Why not the campaign organizations that put stickers all over the subways at election time?"

Withholds Last Name

Figure 10 – Article published in The New York Times about TAKI 183 in 1971 (ext. of New York Times, 1971).

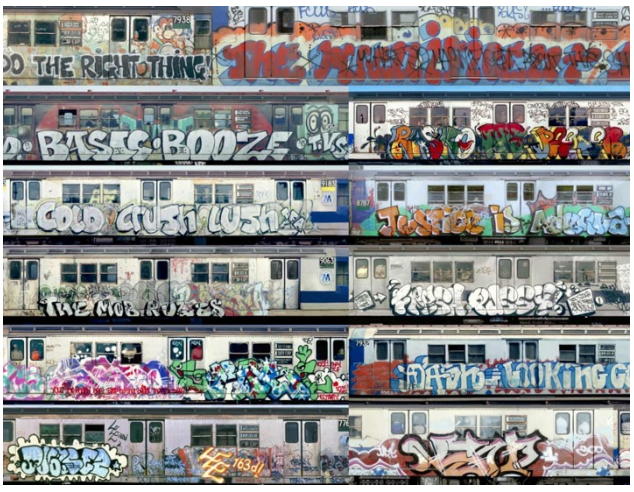

Figure 11 – Carriages painted with end to end (ext. of The Guardian, 2014).

number), a seventeen-year-old greek who executed his tag on New York subway (Figure 10).

Since then, artists have reached public recognition in United States (Cooper, 1984) in magazine articles, films, hip-hop, among others (Wacklaweck: 2008), where the word graffiti began to mean a movement that is executed in public space, in an illegal way. This artistic expression conquered the subway wall (Figure 11), having evolved to a more complex writing, proliferating also in the tunnels and carriages of the underground[5], since the circulation in different lines allowed different writers to be influenced and recognized within their communities (Castro, 2014). Within the underground community, it is possible to capture aesthetic qualities only recognized by the members, with marks and signatures that are not identifiable to the external viewer. Thus, this activity often presents itself exclusively in society by being recognized only in restrict internal contexts, without openness to the outside world, closed in an inner circle only reachable by a specific cultural environment, with its formulas, practice, graphic techniques used in places of difficult access, these were facts that made the urban movement more illegible to the public (Lewisohn: 2008; Campos: 2016).

This kind of artistic expression led to vandalism prevention campaigns in the seventies carried out by the New York City Council that spent thousands of dollars and performed a multitude of removal strategies (Figure 12). The anti-graffiti patrol worked in the underground having the target to fight vandalism, through the application of barbed wire around the yards and the installation of a cleaning system in the carriages, called "the buff" (Kramer: 2014; Cooper, 1984). This new strategy led many writers or crews to leave the underground and to look for other immobile surfaces to express their distinctive art for the time. The days on the subway had finished, where the artists themselves began to document the graffiti, through photography, in order to spread it among their peers. Martha

[5] With various nomenclatures, which extended to the language of the environment and which are still used today, such as the *end to end*, the lower area of a fully painted carriage, the *top to bottom*, a painted carriage from the upper zone to the lower zone, the *whole car*, with the full coverage of a carriage, and the *whole train*, a painting over the entire train (Campos: 2016).

Figure 12 – Photo by Martha Cooper, New York in 1981 (ext. from Lens Culture, 2019).

Cooper and Henry Chalfant (Figures 13 and 14) were the most widespread graffiti artists in New York in the 1970s, through photographic and video documentation[6] that allowed the artistic trend to develop into art history (Urban Nation, 2020; Cooper, 1984).

Other artists found new surfaces due to the need to enhance personal expression and recognition by the community, through the appropriation of supports in public spaces such

Figure 13 –Photo by Henry Chalfant "Dust in the 6 Line Yard" (ext. of Chalfant).

Figure 14 – Photo by Martha Cooper, New York in 1981 (ext. from Lens Culture, 2019).

[6] Wild Style from 1982 and Style Wars from 1983, are documentaries of the time about underground culture, with writers presenting how they accessed the places where they made the pieces, how their writing developed and all the stratagems to escape the police (Ahearn, 1982; Silver, 1983).

as the lower parts of bridges, gates, signs, walls on a corner, among others (Kramer: 2014; Kendall: 2017). The greater the complexity of the composition, the greater the name and recognition within the community. These demonstrations of skill, imagination set by quality not quantity, the masterpieces, or pieces were depicted by complex signatures, using all the available space, with the application of various colours and the inclusion of images, which were optional since the beginning of the movement (Merril: 2015). Meanwhile other artists were looking for legal approaches by obtaining the owners agreement for the walls (Kramer: 2014). This third option, between illegal and legal graffiti, led to a new terminology, a current evolution and a paradigm shift, which questions an essential part of illegal graffiti, the adrenaline. The use of a city space provided by owners, such as abandoned factories, small business, walls, vans or trucks, was quite distinct from the underground context, which led to a new dynamic in the city. This context offered the opportunity of expanding the movement, because it was now possible to create on day light and without the fleeting moment so characteristic of underground graffiti. Since this didn't have yet a lucrative goal implied, most artists proposed the mural work to a certain owner, without a fixed value, only with the requirement of free creation (Kremer: 2014). By one hand, the monetary refusal to create something was based on the assumption that any funding would somehow affect the creative process, which was not appreciated in underground culture. Then, the artistic development was expressed with collaborations between writers or solo (those who had the possibilities to do so), in the form of a large-scale, more complex and creative paintings, for an easier share of costs. On the other hand, with the growth of the graffiti industry, the technical expression was amplified with the introduction of low pressure aerosol inks on the market, which allowed a slower and more uniform release of the paint, a richer colour palette and the use of new dispersion systems, the caps, of greater amplitude and variety of adaptation according to the writer's taste. These led to the inflation of this industry and consequently to the need for a funding support to the artists. Nowadays, graffiti is much more expensive than at the time of its rise. An artist who wants to create something and use the best materials, which are increasingly expensive due to technological evolution, must be funded by someone. As Kramer (2014) pointed out, most writers do not present themselves in adolescence, as some authors say (Wacklaweck: 20011; da Costa: 2016), although there is an initiation in that phase, still illegal. Great murals are created by experienced writers, with long term careers and in a legal way. These writers need a greater variety of colours or at least a greater amount of paint to fill a wide

support that will receive the painting, including most of them express the need for notoriety and belonging to society.

This new paradigm, associated with technological evolution and the consequent high costs, has originated street art, now in the outside of the community (Ganz: 2004). Graffiti, where writers consider themselves "purists", continues to interpret using the same language within the underground community, since they consider street art for society and graffiti for the most closed circles of a certain city (da Costa: 2016). This growth is seen as a revolt in society, distinguished from graffiti by openness to cultural diversity and more accepted for that very reason, because it is readable/understandable to ordinary citizens. Therefore it mixes other techniques besides aerosol painting, such as stencil, stickers, posters, installations and painting techniques with broad languages, distinct from graffiti (Waclawek: 2011; Cushing, 2010), although it still coexists with the appropriation of specific spaces and/or urban furniture, such as poles, electricity boxes, telephone booths, among others (da Costa: 2016). This development could be seen as a renaissance of illegal art in the SoHo block of New York City, not only chronological, but also of formal, material and visual enlargement that in the eighties and nineties promoted initiatives of creativity and artistic manifestations and could be called, also post-graffiti, by some (Hughes, 2009; Eugénio, 2013; da Costa:2016; Kendall: 2017). The aggregation of a panoply of materials leads Hughes (2009) to declare that street art does not present barriers, since it appropriates the techniques of painting and graphics already pre-existing by recycling them in the street and built by a interdisciplinarity approach of academic arts learned in Fine Arts (Neves: 2015).

In the first decade of the 21st century the evolution of this artistic practice gained recognition and a great cultural leverage within the institutionalized art market, which consequently led to a new aspect of underground culture (Figueroa: 2016). This artistic evolution could be placed in the sphere of urban art. Associated in the exhibition "Spank the Monkey" in the United Kingdom, born based on the need to relate the art made in the street with the appropriation of buildings and not represented in parallel public spaces (Simões: 2007). Urban art comes in the context of the recognition of the street painter, now invited and payed to paint monumental walls in urban art festivals, institutions or even owners' infrastructures. When the first graffiti manifestations were produced, they were connected to the surroundings of the community and the city in question, as in the case of New York, on the context of urban art, where political and social issues are presented not so much to a more closed nucleus, but to the periphery of the city, with national and even

continental political and social messages. This new vision of the world was boosted by the internet, and the evolution of the communication media (Campos: 2010). The internet boom has also projected most artists, with the propagation of their works on social platforms[7], and it is now possible for the artist to gain recognition outside the museum universe (Perroncel: 2018).

1.2. BRIEF HISTORY OF URBAN ART MURALS IN PORTUGAL

When placing Portugal in the same decade (seventies) as the impulse of Urban Art in the United States, we can say that we were still far from thinking that such a movement was emerging on the other side of the Atlantic.

After the fall of the *Estado Novo*[8] in April 1974, the lack of freedom over almost forty years under the dictatorship boosted the freedom of expression on the grey walls of the city. Both artists and politicians fulfilled the city walls through informal graphic appropriations (loose phrases, slogans and artistic expression) and political posters, which included various techniques for expression, such as carvings, rolls, stencil, aerosols, collages, etc. (Campos, 2016; Neves, 2015).

With the implementation of Democracy, the country opened its borders to the rest of the world, and from the eighties, underground cultural influences crossed the barriers of a backward country. Hip-hop fever influences the country's young people, but without creating much commotion until the 1990s, with the first tags, influenced by international writers Shoe and Wolf, and a European, writer Kazar. Criminal Assassins Crew (CAC) is the first Portuguese crew, consisting of Mistik, Spin, Safari and Gizmo. Other crews were created by different writers, inspired by the CAC, which fit into the same aesthetic movement as its contemporaries in Europe. In the center of the country, in Carcavelos, the writer Jam, future Nomen, an ally of the CAC, emerges, in partnership with Kase One and the later union with Saxe and Youth. Driving the PRM crew (first called Pyromaniacs and then Paint Rackin' Mafia), making bombing style in the Hall of Fame, near the Cascais line,

[7] *Instagram* as the digital platform of choice for artists (Perroncel, 2018).
[8] New State, *Estado Novo* in Portuguese, was an authoritarian and autocratic political regime that was in place in Portugal for 41 years, approved by the 1933 Constitution until the Revolution of 25 April 1974.

in Campolide, Belém and Amoreiras (Campos, 2016). This crew influences the rest of the country through "its intense activity, the quality of its styles and a strong attitude" (Moore, 2007 apud Simões: 2013, p. 69). Until the end of the 90's, other crews were created, manly in Sintra, Estoril, Margem Sul, Benfica and Almada. New writers appeared since 1994, with influences from new styles produced by Tape, Revolt and Darko. From 1995, the trains in Benfica were filled with bombers and writers as Dose, linked to the crew Fm and FYA, leads illegal graffiti in Lisbon. In the Carcavelos railway line there was also a distinct style, with anarchic inspirations, disconnected from the subculture of hip-hop, the Scum Family Crew, with links to SHARP (skinheads, antirracists and anti-fascists), with paintings of political words (Simões, 2013). In 1995 the police authorities began a series of persecutions of writers, and some members of the PRM crew were caught in the act and subjected to criminal proceedings (Moore, 2007 apud Simões: 2013). Portugal becomes part of a worldwide list of Art Crimes, the first website targeted at illegal graffiti[9]. In the same year, Odeith created the Hall of Fame of Damaia, with a three-dimensional style, propelled by the growth of the graffiti industry in expansion in North America. This industry arrived in Portugal through Polo one of the NCA crew members and the opening of the "Big Punch" shop in Chiado, implementing in Portugal the new low-pressure aerosol technology, the use of new brands such as Sparvar, Montana Hardcore and different types of caps. The "Big Punch" sells Sparvar and the following year Montana Hardcore, as well as auxiliary material (magazines, accessories). Before this, Pluricolor, Dupli-Color and Bricobri were the aerosol paint brands that circulated in the country, with writers creating their own working tools, using needles to create fine lines, perfume diffusers as caps, among others (Moore, 2007 apud Simões: 2013; David, 2017). This emergent art also took place in the north of the country, specifically in Porto, in the early 1990s. According to Castro (2014) who interviewed several artists, the first writers from the north were Maze and Rato54, then Third, Hazul, Bif, Odd, Deck97, Miguel Januário (±maismenos±), Set, Ofek, Fynd and Mr.Dheo. They shared knowledge among themselves because there was not yet much information or quick access to the internet, besides the difficulty of accessing the materials such as spray cans. In the first demonstrations they used chalk, taking several days to complete the pieces (David, 2017, 9.47min.).

[9] Art Crimes site: https://www.graffiti.org/.

As a consequence of this revolution, a new archetype appears, as it happened in North America with, new artistic techniques, expressed by new colours, caps and low-pressure aerosols emerging in the country.

The first national magazine "D'Outros tipos" was created in 1997 and new events and competitions arose which lead to the spread of graffiti in all country.

In 2000 in Lisbon saw the emergence of the LEG crew, bound to the artistic side of graffiti and street art, directed at the Hall of Fame, which included, Klit, Hbsr81, Hium, as original members, who later invited Ram, Wize and Exas, Brai, Chure, Hims and Vhils as the last addition in 2005 (Simões, 2013). In the center of Lisbon, namely in Bairro Alto, there were performed stencil interventions (by a French artist, Nemo), which spread and disseminated this type of expression during 1998. In 1994 during the events Lisbon as European Capital of Culture and late with Expo98, the bohemian life in the city was very active, and this type of occurrences were very widespread. In 2008, the Lisbon City Council withdrew a rule to reduce the night time schedule, as a measure of rehabilitation of the city center, along with actions to clean graffiti and street art. Neves (2015), describes this as "a crucial moment" in Portugal, with the creation of the project GAU, Galeria de Arte Urbana [Urban Art Gallery], in an attempt to create a space for graffiti within the urban rehabilitation of the city, that would bring it closer to Public Art. It also registers several festivals and galleries, with MURO urban art festival, promoting the regeneration and valorization of the city's social districts, the Festival Iminente curated by Alexandre Farto (Vhils) and the Underdogs platform. In Cascais with the Muraliza festival started in 2014 also promoted the valorization of that areas's social districts.

Since the creation of GAU until today, Portugal has been following the world trends, with events targeted to this, both in the islands, with the Walk&Talk Azores, promoted by Anda&Fala, a non-profit association for social insertion through art, as in the interior of the country, with festivals such as WOOL, festival of urban art in Covilhã[10], the first festival in Portugal, which already has had seven editions and aiming to highlight a new perspective of art to the interior of the country, as well as the regional impulse (Rodrigues, 2014). In Viseu, the Festival Street Art of Viseu Tons da Primavera, already its fifth editions and promotes regional products and aims to reach the peri-urban and rural areas (Viseu, 2019).

[10] This festival presents a variant, the Wool On Tour, which first passed through Lisbon, at LXFactory, with two editions, then in Coimbra, followed by Abrantes. The festival has partnered with Festival Cale, in Fundão, with Fusing Culture Experience in Figueira da Foz and also with Mairie du 13e Paris, in France, with the creation of the Tour de Paris 13 project (Rodrigues, 2014).

In Freamunde, PUTRICA is part of the Festas Sebastianas[11], and presents Frederico Draw as artistic director (Teixeira, 2015). In Caldas da Rainha, the FALU festival, with its first edition in 2020, was created after the city being elected the Creative City of UNESCO in 2019 (Gerador, 2020). The ESTAU festival in Estarreja is performed since 2016. In the south of the country, Street Art Lab festival is promoted by the Laboratório de Atividades Artísticas de Lagos [Artistic Activities Laboratory of Lagos]. In Águeda, the AgitÁgueda festival which not only implements wall paintings, but also installations throughout the city.

In Porto, after the local authority approval[12], various entities focused on illustration and urban art, such as Circus in 2012, the first organization in the city to promote and disseminate national art (Castro, 2014). Thus, in the old AXA building, several events were promoted during almost three years, coinciding with the appropriation of the space by the Street Art AXA festival together with PortoLazer, as well as in parallel with Portugal Telecom, that allowed the intervention of the phone cabins in Avenida dos Aliados. In 2014, the Porto City Hall recognized these artistic activities and invites Hazul and Mr. Dheo to paint in some wall of the Trindade car park. In addition to the telephone booths, the electricity distribution boxes in Rua das Flores and Largo de S. Domingos were also an act of artistic demonstration, and later in Rua de Cedofeita, Rua de Miguel Bombarda and Travessa do Carregal, in the context of Street Art Porto Caixas EDP. The Up Street Porto was created as a shared space, workshops, sale of illustrations and street art, based in the Silo Auto. In 2015, the municipal authorities conceded the back wall of the Palácio de Cristal, in a permanence for six months interventions, so called the Mural Coletivo da Restauração. The Locomotiva project, which provided for the rehabilitation of the area surrounding the São Bento train station, with interventions in Rua da Madeira, an area plenty of artistic manifestations (Teixeira, 2015, Silva, 2019). Other spaces of the invicta city display artworks of as Daniel Eime in Largo Artur Arcos, Vhils in Rua da Ancira and Frederico Draw with the mural of the "Anfritião" [host] in a facade next to the top board of the Luis I bridge. The performing of these festivals and projects conducted the ephemeral

[11] Traditional Portuguese festival in honour of São Sebastião.
[12] Under the presidency of Rui Rio in Porto, the law no. 61/2013 was created as a crime against artistic demonstrations on the city walls, with penalties between 100€ and 25,000€. The only possibility at the time to hold a mural, was only foreseen if a licence of 40 euros was paid, which promoted an artistic manifestation up to eight meters, adding 5 euros for each extra meter, besides the monthly rental of public space for 500 euros. The "brigada anti grafitos" was also created, which erased several important works for the history of urban art in Porto. Today, there is already a larger legalization of the walls, through promotion among artists and municipalities (Castro, 2015).

art to a more preserving aspect allowing to the national and international recognition of the artists and positioned this art within an institucional and museological framework bringing conservation issues too.

1.3. BRIEF HISTORY OF URBAN ART MURALS IN ITALY

Hip-hop fever in the United States of America reached Italy in the early 1980s. With the end of the cross-border limits, this new paradigm had identical roots in muralism in Italy between the two world wars, so there is some mention of a return to mural painting, but in a rather obvious context.

Italian mural painting of the twenties and thirties is a recovery of the decorative tradition, influenced by Mexican and Chilean muralism, although with different fronts, on the one hand revolutionary Mexico and on the other fascist Italy (Dogheria, 2014). The period between the world wars was influenced by the new fascism regime that tried to establish a link with the community by transmitting its ideals of civil education and propaganda through this collective art. Two moments triggered fascist muralism, the "Mostra della rivoluzione fascista" in 1932 and the V Triennial of Milan in 1933, promoted by Mario Sironi. Since them, the walls were decorated with pedagogical, formative and doctrinal intentions. The regime lasted until 1943 with the fall of Mussolini during the II World War and the country implemented the Italian Republic in 1946, after a referendum to banish the monarchy. Afterwards, interventions in the street were performed by students of the art academies, collective groups of artists and independent graphics artists who tried to transmit national political-social themes as well as international ones, such as American imperialism, struggles for national liberation in Africa and Asia, as also representation of figures of the revolution, such as Marx, Lenin, Mao and Che Guevara. Themes related to current issues were also expressed, such as women's emancipation, student’s rebellion, police brutality, among others. At the same time, interventions were driven by the movement of requalification of urban areas or small cities through the creation of projects. We can highlight the exhibition "Pittori in vacanza" [Painters on holiday] carried out in 1956, in Arcumeggia, Valcuvia, the first gallery outdoors and considered the first painted village in Italy, which together with the "Casa del pittore" designed by Bruno Ravasi to

accommodate the artists during the interventions; the project was undertaken during several editions until the seventies. The 1976 Venice Biennial and the exhibition of Mexican muralism by David Alfaro Siqueiro prompted interventions with new materials, establishing a dialogue between citizens and the institutions that had commissioned the works (Dogheria, 2015). Of the most striking influences for European muralism came from Chilean groups exiled after the Pinochet political rise, with appropriation and intervention on the walls with protests and political messages supporting Salvador Allende. The Salvador Allende Brigade, characterized by a stylized woman with her arm raised, and the Pablo Neruda Brigade, depicted by a star of the Chilean flag on a closed fist and raised to the sky, stood out as teams of well-organized artists, painting at strategic points in the suburbs, located near industrial structures (Cadetti, 2020; Dogheria, 2015).

This political muralism influenced art trend in Italy during the eighties, in the cities of Rome, Milan and Bologna. It started with Andrea Nelli's "Graffiti a New York" in 1978, the exhibition "The Fabulous Five: calligraffiti di Frederick Brathwaite e Lee Georgdx e Quiñones" in 1979 at the gallery La Medusa in Rome, organized by Claudio Bruni. In Milan at the Paolo Seno gallery and in Bologna, a series of reports by Francesca Alinovi for "Flash Art", that resulted from several trips to New York, together with Barilli, Daolio and Mango organized "Telepazzia", and the exhibition "Arte Di Frontiera" at the Galleria Comunale d'Arte Moderna and Palazzo delle Esposizioni (Rome) in 1984, where several American writers such as Lady Pink, Daze, Toxic and Haring where presented to the Italian public. Contrasting with the United States, this new current evolved from the streets to the exhibition by galleries and museums, mainly influenced by videos by Haring, Scharf and works by Basquiat, as well as documentaries on the subject, such as Wild Style (1982), Style Wars (1983), Beat Street (1984), and in Malcolm McLaren's "Buffalo Gals" at 1982 (Mininno, 2018), including videoclips featuring writers developing a piece. In 1986 several American artists like Ero, Phase 2, Delta 2 and Rammellzee were invited to work in the municipality of Quattordio, sponsored by the Industrie Vernici Italiane (Dogheria, 2015; Cadetti, 2020).

Simultaneously to the exhibitions by American artists, it was only in the 1990s that the artistic impulse of counterculture exploded, with the constant use of railway carriages and written demonstrations on the walls, with letters interlaced, unreadable and unrecognizable. The first writers that appeared in the country were: in Milan, Trilato, Shad, Flycat, Graffio, Dj Elektro; in Treviso, where Mace painted trains with Starch and Tonio; in Bologna with writers Rusty, Wolf, Shorty, Kimet, Yayo, Easy5, Duke 3, CK8 and Pea

(Faiano, 2013); in Rome, the crew P.S.113 (Painters Squad 113) with Napal, Crash and Fab 137 and Breez G. Heavier sanctions were imposed in Milan, in 1993, but on the other hand local authorities provided legal walls for writers. Magazine Aelle appeared in 1995, dedicated to hip-hop culture. This freneticism continued until 2000, with the boost of new products and new industrial brands, and the constant bombardment of trains, including Ferrovie dello Stato trains that crossed the country, which contributed to a greater spread of the various styles in the country. In Milan, with the merger of the crews GR and MDF, the stylization of letters was progressively simplified, registering simpler, capital letters, but elegant and very original, based in Northern Europe, which changed the Italian aesthetic trend and allowed writers a shift from illegible to readable graffiti and thus a larger openness to the community (Mininno 2018).

This trend in order to obtain a better perception of graffiti inspired gradual manifestations such as paste up, stickers, pieces made with industrial inks and aerosol inks, getting more and more new forms of expression that have triggered street art. Writers and academically trained artists have used this new trend by modifying their signature and using logos or a figurative character. The French Honet and Stack brought this new expression to Italy, which pushed up new Italian artists to embrace on this line of manifestation, in addition to the growth of the internet which allowed the access new trends and manifestations from the rest of the world. The Northern cities of Bologna, Turin and Milan were among the first cities to join the new wave of registrations, with artists like Bo 130, Microbo, 108, 2501, Ozmo and Abbominevole. At the same time artistic manifestations with roll painting were made by artists trained in fine arts, standing out Aris, Blu, Dem, Ericailcane with works understandable and loved by the public. Milan still records exhibitions that boosted street art with the Urban Edge Show in 2005, with works by Abbominevole, Blue, Bo130, Galo, Microbo, Ozmo, 108 and 2501. Itinerant event occurred in 2006, called Beautiful Losers, Contemporary Art and Street Culture with a catalogue I Graffiti del Leoncavallo, for the Triennale di Milano. In 2007, Sweet Art held at the PAC (Padiglione d'Arte Contemporanea) in Milan. These northern events went on in Rome with the SM° Scala Mercalli event.

The advent of this illegal art was progressively understandable since 2008 with the Do the Writing! project in collaboration with the Ministry of Youth and INWARD, the International Network for Research and Development in Written Art that fought vandalism through the implementation of various guidelines (Cadetti, 2020; Dogheria, 2015). Meanwhile several entities and initiatives provided the growing appreciation of this art.

Several events were held in the 10th decade of the 21st century, such as PicTurin in 2010, the Outdoor Urban Art in Rome. Draw the Line, 2011, in Campobasso, the Memorie Urbane street art Festival in Gaeta and Terracina. In 2012, in Bologna, the Frontier. La linea dello stile, and in 2016 with the controversial exhibition "Street Art - Banksy & Co. L'arte allo stato urbano" at Palazzo Pepoli. This trend has increased in Rome with several projects to regenerate the suburbs, like the M.U.R.o project in the Quadraro and Torpignattara neighborhoods, the GRAART project, which runs along the Great Raccordo Anulare, a highway around the city, and the Big City project in the Tor Marancia neighborhood in 2015, as in Naples in the problematic suburb of Ponticelli with the Parco dei Murales. This new muralism embraces projects of cities regeneration and aims the requalification of the community and the recognition of artists, as well as being gradually institutionalized by commissions of public authorities (Cadetti, 2020).

1.4. Issues in the conservation and restoration of urban art murals

In recent decades, urban art has developed and obtained great cultural impact in contemporary society, quite distinct from the early days of the movement, where artists were recognized as a cultural sub-product, neglected their illegality, issue that has already been dissipated, due to the pertinent and discursive practices which became increasingly complex (Figueroa Saavedra, 2016; Noguera Camara, 2015).

The bridge between the classic theories of restoration and this type of manifestation is currently under development since these artistic movements are considered as any mural artistic expression. Conservator-restorers are trying to adapt themselves to the latest theories, considering the differences in the new movement and the need to implement conservation actions, taking into account the context, the use, the function in society and the impact that the intervention will have. Within the search for solutions it is pertinent to reorganize restoration theory and outline intervention criteria. The contribution of conservators, historians, artists, critics, curators and other significant agents in the art market must somehow establish, define and delimit which works belong to this field of

expression, in addition to prioritize works according to history, aesthetics and community values (Úbeda, 2015; Getty, 2003; Cadetti, 2020).

Several studies are already being presented that seek to answer to the emergent topics (Cadetti, 2020). Accordingly, groups such as GEIIC, Yococu, The Getty Conservation Institute, Urban Creativity, CaPuS are discussing and studying solutions towards conservation guidelines. The Spanish group GEIIC has already presented in 2016 a specific code of ethics for urban art, gathering the opinion of several entities (Santabárbara, 2018; Amor García *et al*, 2016; Getty, 2003; García Gayo, 2015b).

The major dilemma in this artistic movement are the works of ephemeral nature, made by artists as personal tributes in a particular context. The ephemeral aspect can be seen in city walls materialized in artistic expressions created without permission. These mural works can be obliterated by other artists through the covering with new works, resulting from social codes implemented in the underground culture, in addition to the subjugation of the artist to orders from entities, institutions or even wall owners. On the other hand, there are works respected for their quality, distinguished from others as a new contribution to subversive culture or even by the influence, recognition or complicity that the artist has achieved in the community over the years (Noguera Camara, 2015). The notoriety of the artist, the interest of the owner or the surrounding community, the identity of the work may be altered contradicting the primordial intention of the artist. Taking this into account, the ephemerality and transcendence of the work is questioned (Amor García *et al*, 2016; García Gayo, 2015a). The ephemeral intention of the artist may be contradicted by the desire of conservation of a collective, the community, cultural associations and speculation of interested entities, which identify themselves with the work, aspects that may unbalance the various factors and may facilitate their conservation. Law regulations are not always clear, that is, intellectual and moral rights may belong to the artist, but the owner of the wall and other entities involved may have rights over them. In a case of an ephemeral mural work the conservation conflicts with the decontextualizing or "frozen" in time, without the efemeral that would be natural to it. It is necessary to analyze each case, because the ephemeral may not be forever an intrinsic value (Amor García *et al*, 2016; García Gayo, 2015a). Before performing conservation actions it is necessary to recognize the background of each artistic production to recognize what is intrinsic and what is secondary in a work, beyond the basic values of the artist, such the goals of the author, the history of the work and the context in which it is inserted, in order to find out whether the intervention will enrich or misadjust the meaning of the artwork, beyond the intention of

the artist and the interest of the public (Santabárbara, 2016; Garcia Gayo, 2017; Yngvason, 2003; Figueroa Saavedra, 2016; Sanchez Ponz, 2015). Several studies have already outlined solutions for conservation-restoration interventions of urban art murals through the implementation of preventive conservation, curative and restoration treatments, with examples that allow the safeguarding of murals during a specific time, through criteria established agreed between all the entities involved (Rauseo, 2018, Rava, 2018; Collina, 2018; Dickens *et al*, 2016).

Besides, the musealization of the works, although problematic in itself, is linked to the moral issues mentioned above. If we consider the museum as the traditional space of a closed building, where the works would be lodged inside, it's clear that this concept contradicts the principles of urban art. Furthermore, we have seen in recent years that several artists express their will of not having their works made in walls around the city to be detached by *strappo* and decontextualized in the museum space. However, exhibitions with parts of urban art, not authorized by the artist, are made and in addition, the free access is altered to a paid one. Distinct artists have revolted against this trend by producing statements and interventions, such as the case of Banksy where his works were repeatedly removed, stolen and auctioned without his permission[13], or Blu in Bologna, as an answer to the exhibition "Street Art - Banksy & Co. L'arte allo stato urbano" at Palazzo Pepoli, where he self-destructed his artworks on the city by covering them with ink, that were probably more important than those presented in the exhibition (Santabárbara, 2016; Cadetti, 2020). In order to face this situation, there's a need of regulation and of performing parameters to protect this heritage and its social relevance (Giner Cordero, 2016).

In commissioned or institutional murals, the problem is substantially different, because they are connected with the urbanism of the city. The protection of the works is given by the commissioner or as established in the written contract, taking advantage of the fame of the artist in vogue for his own benefit. When a painting is made on a wall, it belongs to the owner, however, the image still belongs to the artist, therefore, all three parts - the conservator, the artist and the owner - have a voice in the conservation of the work (Getty, 2003; Reiner, 2003). The community also can be a player in the cases of wall paintings from festivals that were covered because they did not coincide with their values. The contents can be attractive for events or festivals in order to integrate deprived areas and

[13] The most relevant case of marketing is the Sotheby's auction of Banksy's works "Girl With Balloon" in 2018. After reaching £1m at the auction, the piece was destroyed with a shredder installed by the artist in the framework. (Johnston, 2018).

transform them into areas of public interest and tourism. In this sense, it can be said that they would be more protected, but in legal terms there are no conservation parameters either. In some situations, projects allow a certain control of the conservation condition, but as they are not included in the cultural heritage legislation, they became themselves irrelevant to traditional conservation and restoration planning. The community can itself be a strong agent of conservation, raising questions about the permanence, through the valuation and protection of the works in the urban landscape and consequent forcing their entry into the history of art. It is crucial that the cultural environment can distinguish the kinds of works that are currently being built, whether they are an act of vandalism, whether they are part of an artistic project, or whether they have the function of valuing an area of the city (Santabárbara, 2018; Sanchez Ponz, 2015).

The evaluation of criteria should correspond to a different model of performance from one work to another, where all the factors involved depend on the entities implicated, as referred above. So, the choice of mural works cannot pass only through aesthetics, regardless of being politically correct or not, since urban art is part of our identity, which suggests that somehow it should be preserved (Santabárbara, 2018). In the article "Preserving Art in Public Places: A Discussion about Mural Painting and Conservation" the interviewee Leslie Rainer states that the choice of mural works to be preserved must be done under the priority criteria: first those which are in imminent destruction or present advanced state of degradation, and only then, those which have a certain level of quality. In addition, it is referred that works should be preserved, regardless of whether if they are or not good artworks. Rainer also says the cultural agents should decide what should be preserved or not, and she, as a conservator is “just there to do the work".

Preservation involves the knowledge of materials and being able to preserve them, so that there is a temporal enjoyment, which will lead to an art permanence. In contemporary art, as in this case, of urban art, the question is complex, because in this case, the fruition is not so literal, presenting material particularities, conceptual processes different from traditional art. It may be necessary to highlight some questions: is it necessary to conserve works that are destined to be ephemeral? How ethical will be intervention of conserving a work produced to be ephemeral? Which works should we save? Why should we do it? What guidelines should be taken into consideration? To conserve it is necessary to listen to all the parties involved who may have an opinion on the value of a work in a public space? (Berti, 2015; Shank, 2015).

CHAPTER II

MORPHOLOGICAL AND TECHNICAL CHARACTERIZATION OF MATERIALS

2.1. SELECTION OF MATERIALS AND ANALYTICAL TECHNIQUES

Urban art was born without expectation of being preserved for a long time, so the quality of the materials is not a priority when creating an artistic expression. The selection of materials for the research took into account the Italian as well as the Portuguese context. The artists sought to execute the mural works with agility and fluidity, so the recurrent use of materials that got this fluidity involves the use of aerosol paints, which allows to cover large spaces in a short period of time. With the artistic evolution of the urban art trend, large companies began to pay attention to this new market, developing a whole new specific products, with low pressure aerosol paints, with a richer chromatic palette and with the use of various dispersion systems, such as Montana™Cans, Montanacolors®, NBQPro®, CLASH® and Loop®, for both the Italian and Portuguese markets (Noguera Camara, 2015).

The materials and techniques used in urban art are much more varied and distinct from traditional painting. Besides the various compounds of aerosol paints, it is common to find mural works made with industrial paints applied to roller or brush, combined various techniques such as direct drawing, stencil or image projection (in the Italian side IVAS appears as the main choice of artists in the use of murals in Rome). With also other types of techniques and materials, like paste up, a technique for gluing posters (e.g. Obey, Berri Blue, Costah), the adhesion of solid pieces with glass tablets or ceramic pieces (e.g. Invader, Maki and Niko), the use of recycled materials attached to the wall and completed with paint (e.g. Bordalo II) were also used. It is also still possible to find visual expressions with perforations of the support carried out by pyrotechnic explosions (e.g. Vhils) or incisions in the support after applying a painting (e.g. Borondo) (Sanchez, 2015; Magrini, 2017; Norbutus, 2015; Castro, 2014).

This research focus on the most used materials by artists within urban mural art (Magrini et al, 2016, Sanmartín, Cappitelli, Michell, 2014) led to an approach of what would be the best coatings for protection against vandalism (Gomes, Dionísio, Pozo-Antonio, 2017; Macchia, et al, 2019a; Macchia et al, 2018a; Garcìa, Malaga, 2012). This protection becomes essential since vandals frequently use have similar materials, that can penetrate and blend with the original paint. The application of a proper protective coating could be helpful in the removal efficacy of vandalism paints without altering, damaging or eliminating the original paint layers. Vandalism carried out by people with spray inks or other similar materials is one of the main factor of degradation of these murals. The lack of protective coatings in the commissioned mural projects has led conservator-restorers to pay

attention to this issue and to develop intervention methodologies. Some entities, such as Yococu (Youth in Conservation of Cultural Heritage), have already developed improved protection for their artworks in the projects M.U.Ro and GRAART (Macchia et al, 2019a; Macchia et al, 2018a; Macchia et al, 2018b). Besides some research working groups have already been established to develop conservation strategies for urban art murals (Macchia et al, 2019a; Magrini et al, 2016; Macchia et al, 2019b), while conservation studies are still focused on the removal of vandalism from stone building surfaces.

The development of a vandalism cleaning methodology for the urban murals (Carreti, Dei, Baglioni, 2003; Baglioni et al, 2014; Giorgi, Baglioni, Baglioni, 2017; Bonelli et al, 2018) is the second focus of this investigation, while taking into account the principles of sustainable intervention. Green solvents allow the replacement of common toxic products with healthier alternatives that are safe for the user as well for the murals and represent an interesting advance in this research area (Balliana et al, 2016; Angelova et al, 2017; Macchia et al, 2019b; Ameta & Ameta, 2013).

2.1.1. Materials

One of the characteristics of contemporary art materials is the variety of new products that are provided by the market, offering a diversity of techniques to artists who can experiment various compounds and mixing products to attempt new characteristics in their work (Magrini et al, 2017; Norbutus, 2015).

The materials used by artists selected for this research include several products sold in Italy and Portugal. Two aerosol brands were chosen, Montanacolors® (MTN94, MTN WB) and Loop®, and a brush application brand, the Ivas® group (Ivas SP and Ivas SA). MTN94 have alkyd resin binder and use ethyl acetate as solvent. Loop has an acrylic binder and uses the same solvent as MTN94, the ethyl acetate. MTN WB uses a modified PU binder and water as solvent. Ivas SP and Ivas SA have acrylic binders and water as solvent. Additives incorporated in the paints are not known beyond the properties already mentioned, but these may correspond to plasticizers (silica, or synthetic aluminum silicates), surfactants and sequestrants (metal ion scavengers), thickeners, stabilizers (pH buffers) and biocidal surfactants (Learner, 1995; Cappitelli et al, 2005).

An exterior south-facing wall[14] was selected as the support for the specimens. The walls used by the artists may not always be properly prepared, taking into account that urban art emergence is linked with the choice of any surface likely to receive a drawing. We find mural works on any kind of support, from the typical Portland cement walls, to brick, stone or even metal surfaces. The vulnerability of certain substrates will allow different surfaces or finishes to end up directing the method of intervention, since a cleaning agent that has previously proven the effective removal of certain aerosol paint may be inadequate depending on the substrate (Sanchez, 2015; Cappitelli et al, 2005). The selected substrates are made of cement coated with an industrial paint[15], since this is the most frequent type of material support than any other in the urban landscape. So, the tests performed were identified and executed as it would be were an authentic case.

The first part of the study involved the choice and selection of various formulas of protective coatings that present ideal characteristics for an effective and correct conservation in urban art murals. These protective coatings provide the benefits of safeguarding the artwork currently and in the nearest future against vandalism, as well providing preventive measures against deterioration of the original materials while not altering the aesthetic appearance of the work by since they are invisible, without shine, resistant to ultraviolet light and not causing early yellowing, not introducing physical or chemical damage, preventing the deterioration of the original material. This depends not only on the materials of the chromatic layers but also on their substrate, so these coatings must also allow the evaporation of humidity while also restricting its entry (Norbutus, 2015). One of the important factors regarding a protective coating is its reversibility, the ability to be easily removable without damaging the underlying layers, using different solubility parameters of the chromatic layers as long as they are stable for a long period of time (Macchia et al, 2019a). The majority of the selected products are anti-graffiti commonly used for building heritage and only one specifically developed for urban art murals. Four protective coatings were chosen: KEIM®, IMAR®, IBIXBiocare®, and lastly, Pro-art developed by Yococu in partnership with Pelicoat®.

Several organic solvents, considered green, were selected for cleaning tests. The definition of green products for art conservation takes into account not only the effectiveness and safety of the work, but also the health of the operator and impact on the

[14] The wall provided is located in Yococu's laboratory, as can be seen in Fig. Att. 1. Tests were carried out in the second week of October.
[15] The wall provided already had the orange industrial paint.

environment. The contemporary art conservator struggles to choose materials that do not damage acrylic paints (used in urban art murals), characterized by a low Tg (glass transition temperature). Paints exposed to the outdoors may suffer an accelerated degradation process, and in a few decades the molecular breakdown of the binder may be visible through cracks, fissures, leaching and discoloration (Macchia et al, 2019b; Crescenzo et al, 2014). Low Tg values makes the paint texture soft and sticky at room temperature which leads to the accumulation of dust or dirt easily (Fardi et al, 2018). Besides the problem of dust accumulation, urban art murals are faced with human vandalism. Vandals use similar materials as the original artist, with the same solvents and even binders, which may dissolve and establish a bond with the different layers of paint (Garcia & Malaga, 2015). Since this research also includes the study of chemical cleaning methods for urban art murals that have aerosol paints applied directly to the works without any kind of protective coating, a set of solvents were selected, that together integrate the solubility parameters of acrylics. The following solvents were used to mix solutions: distilled water; two surfactants (Tween20 and Sodium Laureth Sulfate); ethyl alcohol; acetone; dibasic esters (DBE-LVP); and a furfural derivative (2-methyltetrahydrofuran).

2.1.2. Analytical Techniques

Inks used in urban murals are mainly composed of pigments, that provide the color, joined to a binder that allows a transparent film that hardens and links the dispersed pigment and the solvent allowing for a greater or lesser viscosity to the other compounds. Although the composition of the ink seems to be relatively discernible from brand to brand, the problem occurs when analytical tests are performed and formulas become very difficult to differentiate, since the brands retain some important information about the specific characteristics of the composition, revealing only general information such as alkyd resins, acrylic resins, or mixtures of various types (Noguera Camara, 2015). Due to the diversity of compounds and products that are incorporated, it is necessary to understand how they act and interact with each other and which are the potentials of degradation, in an attempt to properly consider the intervention plans in a mural work (Sanmartín, Cappitelli, Michell, 2014; Jablonski et al, 2004).

Three analytical techniques were used in the investigation of the protective coatings, in order to visualize the morphological reactions of the chromatic layer in relation to the use of different protective coatings that were tested. One of the most relevant components of preventive conservation is based on the aesthetic and proper presentation of the mural work, assuming that it may be compromised with the use of external products. The execution of analytical techniques is an essential procedure to revise these modifications and find out which coatings are more capable of fulfilling the function. An optical microscope was used to possible to observe in detail the surface of the paints, such as their reaction in relation to the coatings applied, as well the thickness of the chromatic layers through the stratigraphic cut of each sample, the penetration of the protective coatings and the vandalism applied. Samples collected from the specimens were used for both optical microscopy and SEM/EDS analysis. SEM/EDS allows a more detailed morphological visualization, while allowing the detection of chemical elements and their location in the stratum, through coupling of X-ray spectrometry with scanning electron microscopy.

2.2. METHODOLOGY PROCEDURES

2.2.1. Preparation of specimens

In the outer area of Yococu's laboratory, located in a peripheral area of Rome, Magliana, it was selected a wall, faced to south wall presenting exterior paint in orange color.

Several specimens with the same size were made in the south wall, using a circular stencil. Each selected paint was applied successively horizontally until it comprised twenty specimens, including an isolated specimen in the adjacent one, to be used as control. 200 specimens were made in two blocks of five rows of twenty circular specimen with seven-centimeter diameter, as shown in Figure 15. The first block, with specimens from 1 to 20,

is intended for coating tests and the second block, with specimens from numbers 21 to 40, is intended for cleaning methods.

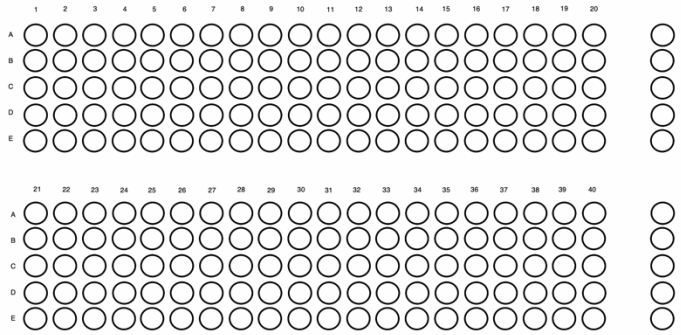

Figure 15 – Prototypes scheme.

The selected inks were tested individually, regardless of whether in real mural works they were used mixed or overlapped. They were vertically aligned as follows: Montana 94 (A), Ivas Superquarz Plus (B), Loop (C), Montana Water Based (D) and Ivas Idromatt (E), as shown in Table 1[16]. This set of paints includes the diversity of the paints used by the Italian artists, as well as a connection to Portuguese through the Montana 94 paint. The use of aerosol paints continues to be the technique of choice in the artistic environment since the early days of this art, although currently the expansion of outdoor paints provides a faster, cheaper and less toxic solution for the artist due to its aqueous emulsions. The aerosol paint, Montana 94 (A), is presented as an aerosol paint with butane and propane propellant, ethyl acetate solvent and with a modified alkyd binder, showing a fast drying formula, good flexibility, good abrasion resistance, which does not contain heavy metals and have a good resistance to weather changes and UV light[17]. Ivas Superquarz Plus (B), has a formulation based on fine quartz particles in an acrylic resin in aqueous emulsion and also presents in its composition biocidal additives against biological contamination, resistance to whether fluctuations and matt finish[18]. Loop (C), is an aerosol paint with butane, isobutane and propane propellent, with highly pigmented acrylic binder and ethyl acetate solvent. Montana Waterbased (D) is an aerosol paint has aqueous dispersion and modified PU binder, water solvent with alcohols (isopropyl and ethyl) and dimethyl ether,

[16] Vd. Fig. Att. 2.
[17] Vd. Montana94 Technical and Safety Data Sheet in Computer Sources.
[18] Vd. Ivas Superquarz Plus Technical Data Sheet in Computer Sources.

with a matt finish[19]. Lastly, Ivas Idromatt (E), has acrylic binder, diluted in water and a matt finish [20] (Table 1).

Table 1. Details from paints used in the research.

	Products	Application	RAL[21]	Acronyms	Thinner
A	Montana 94	spray	Bourdeux red RV-3004	MNT94	Ethyl acetate
B	Ivas Superquarz Plus	brush	RAL-3004	IVAS SP	Water
C	Loop	spray	Bristol 143	LOOP	Ethyl acetate
D	Montana Water Based	spray	Carmine W-3004	MNT WB	Water
E	Ivas Idromatt	brush	Ral- 4010	IVAS SA	Water

2.2.3. Protective coatings tests

For the protective coating tests, specimens from the first block of specimens were selected. The investigation was divided into two parts: using the specimens A and B and the numbers 1-8, and 31-34 for the OM and SEM/EDS analyses[22]; and application of coatings and saturation tests of specimens A to E with numbers 9 to 20[23].

Considering its harmfulness for the operator, the formulations are based on aqueous emulsions, reflecting a green aspect, as also the environments impact, being unnecessary the use of PPE safety equipment. Protective coatings with the following characteristics were chosen: IMAR®[24], formulated with a wax base and flourinated polymer in an aqueous emulsion; Pro-Art, a coating formulated specifically for urban art, developed by Yococu in

[19] Vd. Montana Water Based Technical and Safety Data Sheet in Computer Sources.
[20] Vd. Ivas Idromatt Technical Data Sheet in Computer Sources.
[21] RAL is a classic colour system. Numeric list for each colour presenting several catalogues for different sectors. As an example, decoration inks RAL K7 or RAL K5 are used, which displays matte and glossy colours.
[22] Vd. Fig. Att. 3 and 4.
[23] Vd. Fig. Att. 5.
[24] Vd. Fig. Appx. 1.

partnership with Pelicoat®[25] and an flourinated polymer in aqueous solution; IBIX[26], also an flourinated polymer compound dispersed in an aqueous emulsion; and KEIM, an acrylic flourinated copolymer in an aqueous emulsion, a coating composed of wax emulsion (Table 2). These coatings have flourineted polymers in their formulation because they have excellent properties for the conservation of a mural work, such as low surface energy, water repellency, chemical resistance and electric insulation (Imae, 2003). Pro-Art also has a UV stabilizer, in order to minimize colour degradation.

Table 2. Coatings used in the research.

Commercial names	Application	Composition	Manufactured	Acronyms
Antigraffiti I.M.A.R	brush	Base of wax and fluoropolymer in water emulsion	I.M.A.R Italia SRL	IMAR
Pro-ART	brush	Fluorinated acrylic resins	YOCOCU / Pelicoat	Pro-Art
Protect IT 100/HBG	brush	Polymer fluorinated in water dispersion	IBIX Biocare	IBIX
AG09W	brush	Resins based on microcrystalline waxes	KEIM	KEIM

During the first research phase, samples were taken from test specimens A and B, after applying one coating for every two test specimens, to a total set of eight test specimens for each paint (A and B). A simulation of vandalism was applied on the second test specimen of each coating, as can be seen on Figure 16. MTN94 (A) and Ivas SP (B) inks

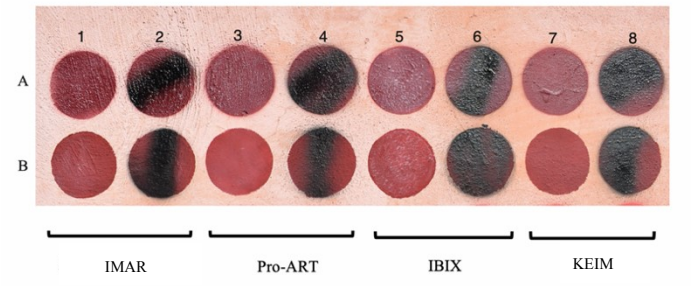

Figure 16 – Specimens of protective coatings for OM and SEM/EDS analysis.

[25] Vd. Pelicoat, Pro-Stone Data Sheet in Computer Sources. Cfr being a partnership with Yococu entity, there isn't a data sheet at the moment, but the basis of the formula is identical to Pro-Stone according to Doctor Andrea Macchia and Doctor Laura Rivaroli.
[26] Vd. IBIXBiocare, ProtectIt 100/HBG Data Sheet in Computer Sources.

were selected, as they showed greater differences[27] in their binder and pigments. A 5% scattered TiO_2 marker was incorporated into each coating for better viewing and reading in SEM/EDS analysis[28]. Due to analyses uncertainties analyses in SEM/EDS made with TiO_2 samples, a new marker was used. Zinc was introduced in the KEIM coating in a 5% percentage. New sampling was performed in specimens A and B from numbers 31 to 34 and a simulation of vandalism was applied to half of each specimens[29]. These second samples were taken and analyzed to compare the results obtained by SEM/EDS with the 5% TiO2 scattered.

In the second phase of the research, two coating layers were applied in two phases. First after drying the chromatic layers and second after ageing them for four months. This application concerned three specimens of each chromatic layer from specimens number 9 to 20. An applicability evaluation over the chromatic layers was performed by the operator[30].

2.2.3.1 Colorimetric analysis

In order to assess colour changes in the tested specimens with protective coatings, it became necessary to apply colorimetric analyses, performed on specimens from A to E with numbers 9 to 20.

Measurement of colour parameters calculates the reflection ratio of the incident light (visible spectrum) from a sample by characterizing the three colour measurements of luminance (L*) and tone (a* and b*) and their relation to each other. The following calculation was used for the CIELAB 1976 to quantify the colour variations in the three measurements (McDonald, 1997):

$$\Delta E^*_{ab} = \sqrt{(L^*_2 - L^*_1)^2 + (a^*_2 - a^*_1)^2 + (b^*_2 - b^*_1)^2}$$

[27] MTN94 has an alkyd binder with synthetic pigments. Ivas SP has acrylic binder with quartz pigments. These quartz pigments are mineral silicon dioxide. When pure they are usually white or colorless, but when they have impurities, they can appear in multiple colours with grain size between 0.06 to 1μm (Eastaugh *et al*, 2008).
[28] Vd. Fig. Att. 7. Was made three percentages of TiO_2 dispersed in the KEIM coating, 2.5%, 5% and 10%, was chosen 5% by the uniform spreading in the layer.
[29] Located in the second block of specimens, because the first block no longer shows specimens with samples of A and B ink (MTN94 and Ivas SuperQuarz Plus). Vd. Fig. Att. 4 and 8.
[30] Vd. Fig. Att. 5.

Where ΔE represents the variation in parameters L*, a* and b*. Two portable spectrophotometers, using visible light, were used to record the colorimetric measurements of the specimens, the 3nh NS820 and the 3nh YS3060[31], both with a diameter of Ø 4mm measuring aperture, optical geometry de 8º and use of a standard illuminant D65. The first equipment was used to measure specimens only with chromatic layers[32], and second equipment, for recording measurement of specimens with a protective layer after the ageing of 4 months[33]. The quantification of colorimetric differences (using the above formula) was performed between inks and four months applied coatings[34].

2.2.3.2 Collection and preparation of stratigraphic samples

To quantify the thickness and characterize the constituent layers of the specimens, 16 samples marked with TiO_2 were collected (Figure 17) and 16 samples marked with Zn. Fragments with approximate dimensions of 1 cm were removed with scalpel in order to be observed by optical microscopy and analyzed by scanning electron microscopy with X-ray spectrometry by energy dispersion.

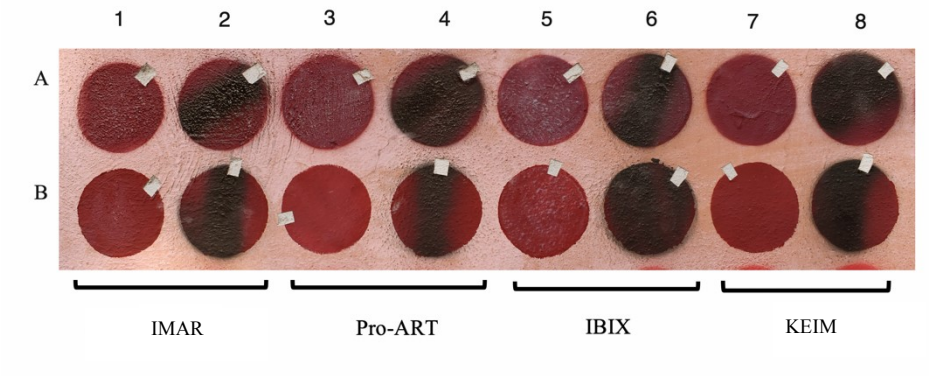

Figure 17 – Sample collection from specimens A1-8 to B1-8.

The incision in the samples was assisted with a scalpel, comprising all the layers present in test specimens A1-8 and B1-8 (TiO_2 samples), as well as in specimens A31-34

[31] Two spectrophotometers were used at different times due to the unavailability at the time of one of them.
[32] Vd. Att.Table 14.
[33] Vd. Att. Table 15.
[34] Vd. Att. Table 16.

and B31-34 (Zn samples). Samples A1-8 and B1-8 were embedded in two-component Araldite® 2020 resin (containing the 2020A resin and 2020B hardener) embedded the samples taken[35][36]. Samples A31-34 and B31-34 were embedded in Technovit® 4004 two-component acrylic resin after analysis in SEM/EDS[37], for a better visualization of the stratigraphy and thickness of the layers, following standard stratigraphic methodologies.

2.2.3.3 Optical microscopy

Optical Microscopy was used for detailed observation of the surface, analysis of the various stratigraphy of the samples and to verify the penetration of vandalism simulation on the chromatic layers. Samples A1-8 and B1-8 were observed with different magnifications under a Zeiss Axiobal microscope equipped with a digital camera and axiovision software[38]. Samples A31-34 and B31-34 were observed with different magnifications under an Olympus BX51 microscope equipped with an Olympus EP50 digital camera lighted with an Olympus U-RFL-T[39]. Both equipment's allow the visualization of various layers, colour and thickness of each layer, as well as the morphology of the constituent particles.

2.2.3.4 Scanning Electron Microscopy with Energy Dispersive Spectrometry (SEM/EDS)

Detailed analysis of the morphology and constituents of the chromatic layers was achieved with a scanning electron microscope coupled with X-ray spectrometry. This technique allows the identification and localization of the chemical elements in the stratigraphy of the sample, that is, a map of the various elements on the cross-section of a

[35] The procedure comprised a mould on an initial base of already polymerised resin, with the constituent layers being placed parallel to the bottom of the mould and then the rest of the mould being filled with resin, covering the whole sample. After the samples were cut with a Buehler Iset Low Speed equipment and roughened with sandpapers of different granulometries until the samples were cross-sectioned.
[36] Vd. Fig. Att. 12.
[37] Vd. The second sampling phase was not embedded in epoxy resin as transverse breakage would be required for SEM/EDS analysis as described in section 2.2.3.4 Scanning Electron Microscopy with Energy Dispersive Spectrometry (SEM/EDS).
[38] Vd. Fig. Att. 13 to 25.
[39] Vd. Fig. Att. 26 to 41.

certain sample. The main objective of the analysis was to verify if the coatings applied to the samples were suitable and if have protected the chromatic layers from vandalism simulation. These analysis were performed in institutions partners of YOCOCU, in three moments : the first, with samples of TiO_2 marked protective coatings, performed in high vacuum, using a scanning electron microscope JEOL JXA-8230 with WD/ED combined systems (Università della Calabria, Departamento di Biologia, Ecologia e Scienze della Terra laboratory), with each sample having been previously coated with a carbon fine film, in order to improve the conductivity of the sample surface; second, with samples taken from the same location, still marked with TiO_2, but only samples A3-A4 and B3-B4[40][41],performed under vacuum with a Tescan VEGA3 scanning electron microscope (Museu della Cività in Rome); finally, new marker Zn was added to the protective coatings for a better visualization of the location of the protective coating, also carried out under vacuum and with the same electron microscope as the second moment.

2.2.4. Chemical cleaning tests

2.2.4.1. Green products selection

Solvents were selected based on their low toxicity, as well as of low production of environmental waste. The cleaning of mural works is considered an irreversible procedure, since the choosing of the level of cleaning is difficult and therefore slow expensive. Often the choice of products depends only on the condition of the mural work, without causing risks for the conservator and, the environment and waste (Balliana, 2016). In this study, these factors were considered primordial having decided to make a sustainable choice of industrial products, adapting these to conservation, as also considering the compatibility with materials used in urban art murals.

In recent years, the substitution of toxic products, with high evaporation (VOC's) and long atmospheric lifetimes by more sustainable products ones, became common procedures, with new and increased standards, both nationally and internationally, such as

[40] Vd. Fig. Att. 8.
[41] Corresponding to the application of Pro-art coating on MTN94 and Ivas Superquarz Plus paints. This second analysis was defined only by taking samples corresponding to the most distinct paints (with different porosities and properties) and the protective coating that best suited the visual tests carried out by the conservator.

the adoption by the European Union of REACH (Registration, Evaluation and Authorization of Chemicals) in December 2006 which allowd to establish the different toxicity level of products (Matlack, 2010), as well a greater awareness of environmental preservation, health of the operator and the impact on the mural work (Burke, 2011). In cleaning operations, the choice often goes to solvents that are effective, fast and inexpensive. The problem usually associated with them is their toxicity. Conservators are familiar in using individual safety equipment, but sometimes neglect it, resulting in cumulative effects on health. To face with this problem, the solution is to find products which are considered green, i.e. which are non-toxic or which at least mixed with other solutions reduce toxicity on the basis of exposure to a given substance, in addition to having a low percentage of biodegradable waste (Balliana, 2016; Lancaster, 2002).

2.2.4.2. Solvent blends selection

The samples of the second built block (21 to 30) were used for the study of vandalism cleaning systems in aerosol-based murals[42]. A black vandal simulation was applied to each specimen, using a MTN94 Black R-9011 aerosol ink, considering the same thicknesses of the vandalic layer and the same area occupied in each specimen (Figure 18).

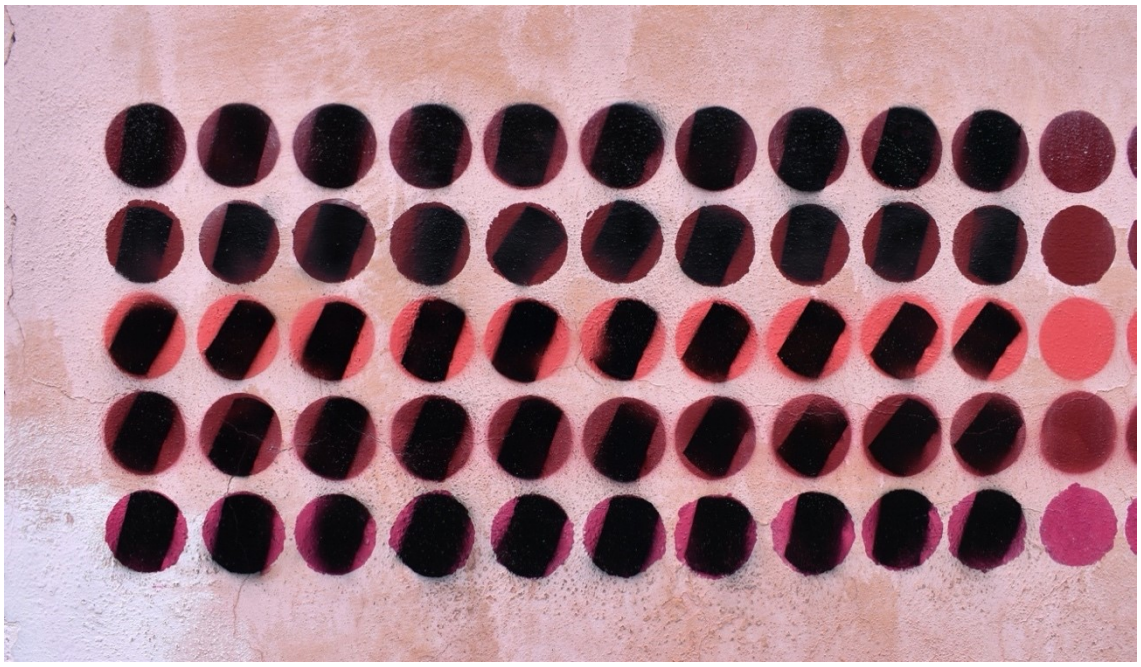

Figure 18 – Vandalism carried out on selected specimens for cleaning tests.

[42] Vd. Fig. Att. 6.

Green organic solvents, as previously defined, and “no green” solvents, but with particularly efficacy as acrylic remover, were chosen within the group of acetones, alcohols, acetals, as well as the "universal solvent", water, complemented with a surfactant, through the visualization of safety data sheets and exposure limits, in addition to the implementation of the cohesion parameters between the various solvents and fractional model of Teas. The use of potentially toxic materials for humans, was necessary to increase the rate of solvents evaporation. However, their use in mixed with green solvents can reduce the percentage and risks accumulated in exposure. The Teas graph also allows the selection of zones of solubility, and prevision on the easiness of removal without traditional toxic products associated to modern materials (Burke, 2011). This theoretical manipulation on fractions reduces to a minimum the errors of experimentation and allows the most correct decision on the mixture of two or more solvents that focus on the appropriate solubilization window, which alone did not permit it. A system developed by Hansen in 1966, relating all values to a single Hildebrand value when all fractions are together, result in the sum that is the Hildebrand value for a given solvent (Burke, 2011; Hansen, 2007). Jean P. Teas in 1968, developed a two-dimensional graph, known as the triangle of Teas, that allowed the easy visualization of the complex systems of solubility through the forces of dispersion (fd), polar (fp) and hydrogen (fh), so the solutions could be built through the percentages of Hansen and not only through a Hildebrand value for a given product. These fractions when added together should always have a value of 100, the results may not be accurate and always will be a margin of error due to the same Hildebrand value (Burke, 2011; Macchia, 2019b). Equations 1, 2 and 3 have been used to quantify the fractional solvent parameters (Barton, 1991):

Equation 1: $$f_d = \frac{\delta_d}{\delta_d + \delta_p + \delta_h}$$

Equation 2: $$f_p = \frac{\delta_p}{\delta_d + \delta_p + \delta_h}$$

Equation 3: $$f_h = \frac{\delta_h}{\delta_d + \delta_p + \delta_h}$$

For the formulation of cleaning systems, data acquired from the host entity YOCOCU was used, which already performed some tests with the chosen solvents and their blends. To improve the cleaning efficacy new solutions were made and applied in the samples of the second block (Fig. Att. 6). The solutions were carried out by identifying the various free solvents and graphically intercepting them through various proportions, which can be verified in Table 3 and Figure 19 and 20.

Table 3. Solutions used and system of solubility through the forces of dispersion (fd), polar (fp) and hydrogen (fh), using Equation 1*, 2** and 3***.

Solutions	Solvents	% (v/v)	fd*	fp**	fh***
1	Etanol	55	46,45	19	34,55
	2-MeTHF	10			
	H_2O + Tween 20 (2%)	35			
2	Etanol	70	33,6	16,4	50
	Water + Tween 20 (2%)	30			
3	Etanol	70	33,6	16,4	50
	H_2O + Sodium Laureth Sulfate (2%)	30			
4	Etanol	70	41,4	19,1	39,2
	Acetona	30			
5	DBE-LVP	20	40,4	14,8	44,8
	Etanol	70			
	H_2O + Tween 20 (2%)	10			
6	2-MeTHF	50	46,1	18,4	35,5
	Etanol	20			
	H_2O + Tween 20 (2%)	30			
7	DBE-LVP	10	41,3	15,2	43,5
	2-MeTHF	10			
	Etanol	70			
	H_2O + Tween 20 (2%)	10			

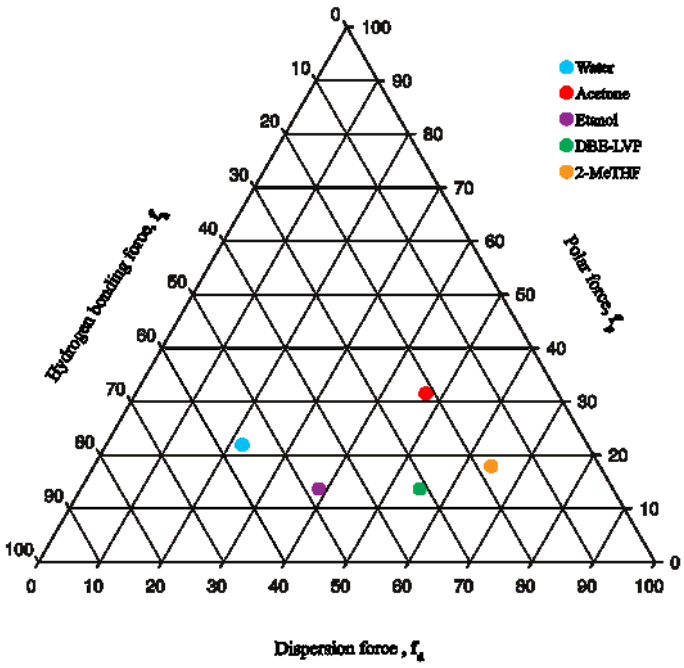

Figure 19 – Solvents representation in J.P. Teas solubility system.

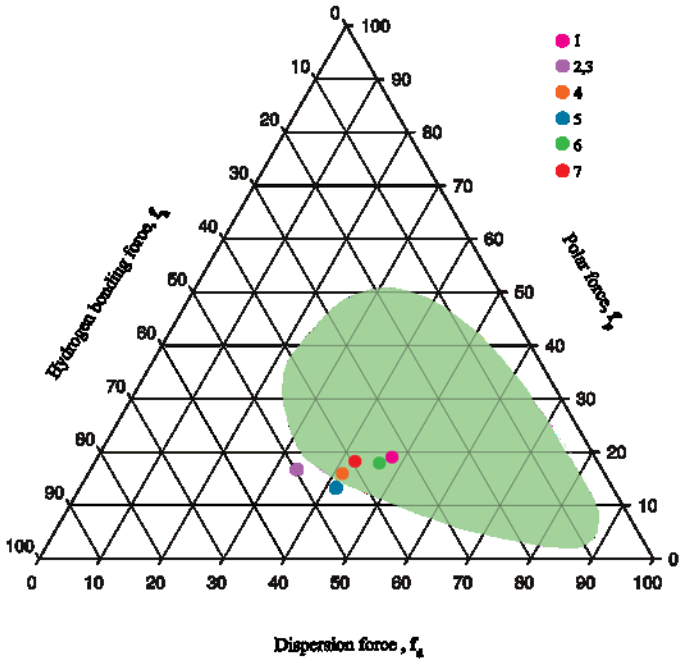

Figure 20 – Solvents blended representation in J.P. Teas solubility system.

The methodological process involved the approval of the various solutions within the zone of partial or total solubility of acrylic paints (Barton, 1991), and also the visual comparison by the operator between the selected paints and chosen solutions. The same criteria, such as cleaning time, area and quantity of solvent were checked and applied, to ensure that the various cleaning parameters were the same.

Ethanol and water were chosen as main constituents for the solutions due to their ability to change polarity in a solution, to improve conductivity between the various reagents, to have miscible qualities with all the solvents used, by their properties that could contribute to increase or decrease the effectiveness of each solution, regardless of the composition of the paints, as well as reduce toxicity. The presence of detergents in a low percentage of 2% in water allows for a better wetting of the surface, as well as a better dissolution of possible fats in the surface of the mural to be cleaned. The remaining solvents used were selected because of their effectiveness in removing the various aerosol paints, while presenting low toxicity and environment impact. Low evaporation may be the only drawback, which was overcome with mixtures on acetone and ethanol. The use of J.P. Teas system of solubility has allowed a more controlled blends study, using an empirical process would take more time for reaching suitable solutions for cleaning aerosol ink.

2.3. RESULTS

2.3.1. Protective coatings

The parameters of luminosity, colour, application form, visual and optical alteration were considered as related to the use of protective coatings. Application methodology, OM, colorimetric analysis and SEM/EDS were used to quantify them.

Regarding the applicability of coatings presented in Table 4, the Pro-Art and KEIM coatings were the most suitable for all the inks tested. It is also possible to verify that for the Ivas SP ink (B) these coatings performed poorly due to its rapid impregnation in the substrate, mostly because of the high porosity (due to quartz pigments) that this ink presents. The other two coating products (IMAR and IBIX) obtained identical results (Table 4 and Att. Table 6).

Table 4. Applicability of protective coatings over chromatic layers. Scale from + (bad) to +++ (very good).

		Protective Coatings			
	Inks	IMAR	PRO-ART	IBIX	KEIM
A	Montana 94	+	++	+	++
B	Ivas SP	++	+	++	+
C	Loop	+	+++	+	+++
D	Montana WB	+	++	+	+++
E	Ivas SA	+	+++	+	++

The impregnation of coatings tested in Ivas SP ink was also confirmed by SEM/EDS analysis, which can be viewed and compared in the Att. Table 17. The impregnation of TiO_2 in all layers was visualized both in the vandalized samples and in the samples without vandalism. This dispersion may have occurred because: a) all the selected inks may have been porous and the protective coatings penetrated the chromatic layers; b) propellant in vandalic aerosol paint may have caused solvent pressure, dissolving the protective coatings and consequently penetrating the chromatic layer. Also, TiO_2 coating layers are not visible in optical microscopies images[43].

SEM/EDS while using Zn as a marker, registered for samples without vandalism, a homogeneous layer in all protective coatings on MTN94, and in Ivas SP impregnation of all coatings in the chromatic layer. In vandalized samples the impregnation of Zn in both inks was visualized (Att. Table 17). However, images obtained by optical microscopy show a layer of coating in both inks without vandalism[44]. Although the impregnation of vandalism in the chromatic layer was visible in SEM/EDS vandalism images, optical microscopy confirmed a thin coating layer between chromatic and vandalism layers[45].

[43] Vd. Fig. 13 to 25.
[44] Vd. Fig. Att. 26, 28, 30, 32, 34, 36, 38 and 40. Figures of optical microscopy images with coatings over MTN94 and Ivas SP.
[45] Vd. Fig. Att. 27, 29, 31, 33, 35, 37, 39 and 41. Figures of optical microscopy images with vandalism over coatings in MTN94 and Ivas SP.

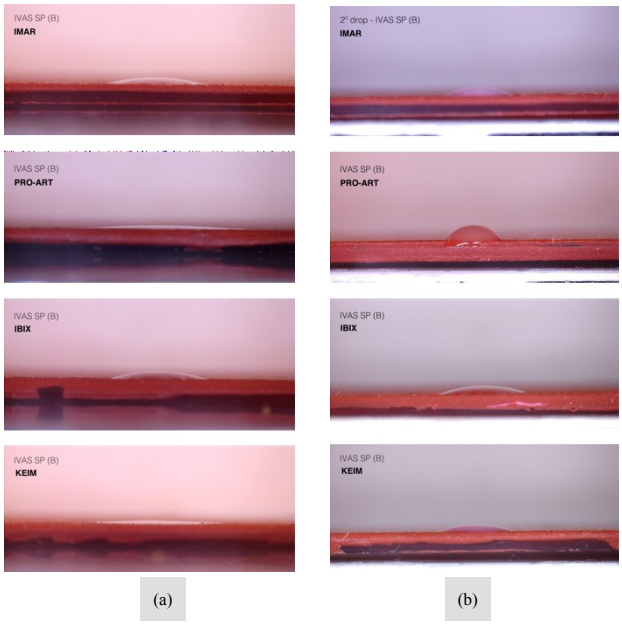

Figure 21 – Coatings wetting test on Ivas SP: a) first coating drop; b) second coating drop.

Impregnation of coatings on the Ivas SP, was also verified in wetting test[46]. One drop in any coating was instantly absorbed by Ivas SP, but a second drop applied shows a bigger contact angle, particularly in Pro-Art coating (Figure 21).

This lower wetting is related to the creation of a hydrophobic surface. A new layer of coating was applied and vandalized in specimens that already had a protective coating layer (specimens A to E with numbers 10, 13, 16, and 19). It was verified that vandalism was dispersed in Pro-Art coating that behaved as a hydrophobic surface (Figure 22), while other coatings didn't have the same behavior.

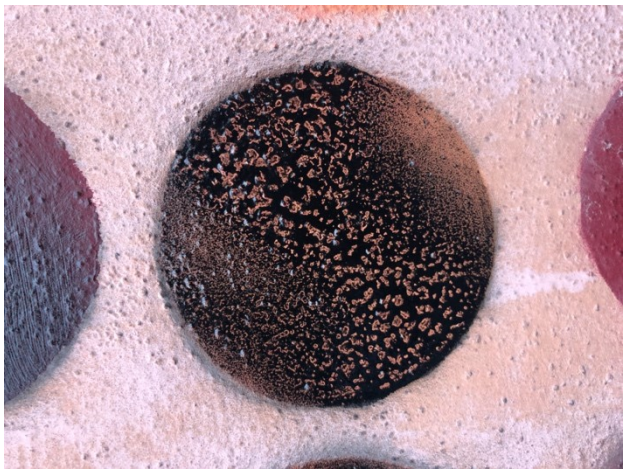

Figure 22 – Second layer of Pro-Art protective coating with vandalism.

[46] Vd. Fig. Att. 9. Although it was not possible to calculate the respective contact angles, it was possible to compare the wetting of the protective coatings on a surface, in this case the selected paints.

Colorimetric measures performed and evaluated between inks[47] and on four months applied coatings [48] register different values for each ink [49]. IMAR registers a good performance in MTN94[50] and in IVAS SA[51], but in other inks presents a bigger difference (Figure 23). Pro-Art shows best performance in MTN94[52], in IVAS SP[53] and in MTN WB[54], with the worst difference in LOOP[55] (Figure 23). IBIX doesn't registers a good performance in any ink. KEIM coating shows the biggest difference for all inks. Ivas SP ink shows that coatings performance was not consistent and was quite different compared to other paints (Figure 23). As seen in Figure 24 the evaluation of the average difference values between all paints and aged coatings, shows that Pro-Art is the most suitable coating for all paints.

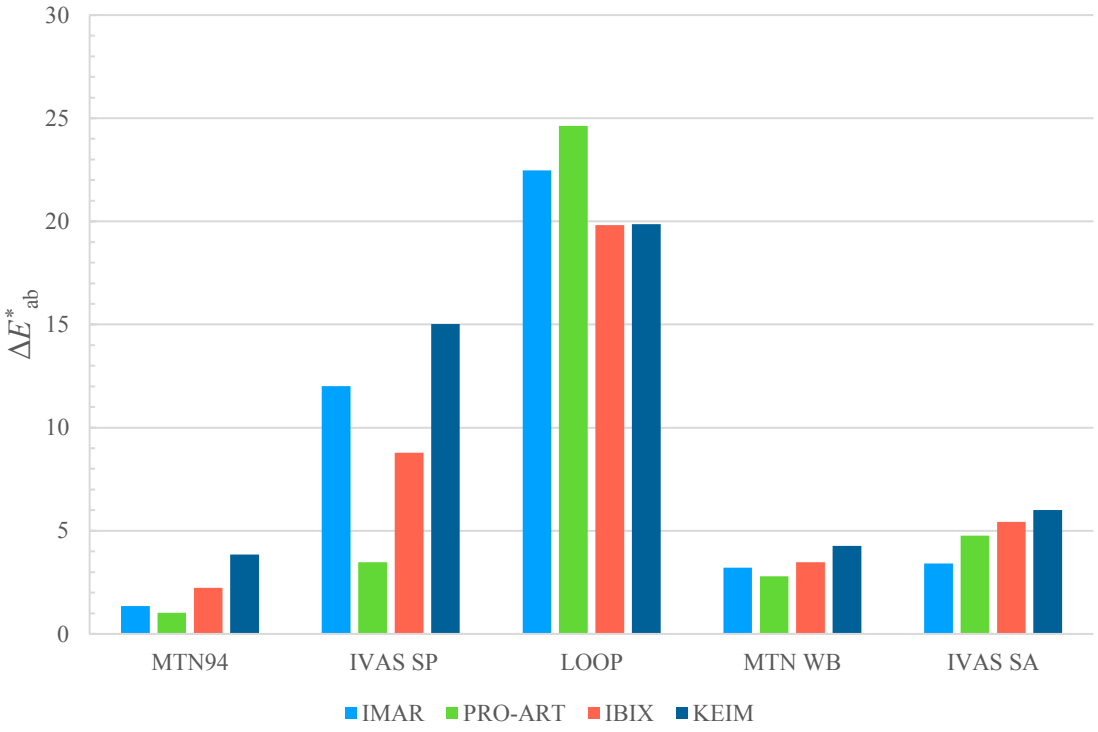

Figure 23 – Colorimetric measures evaluated between all inks with four months applied coatings.

[47] Vd. Att. Table 14
[48] Vd, Att. Table 15.
[49] Vd. Att. Table 16.
[50] Vd. Fig. Att. 42.
[51] Vd. Fig. Att. 46.
[52] Vd. Fig, Att. 42.
[53] Vd. Fig. Att. 43.
[54] Vd. Fig. Att. 45.
[55] Vd. Fig. Att. 44.

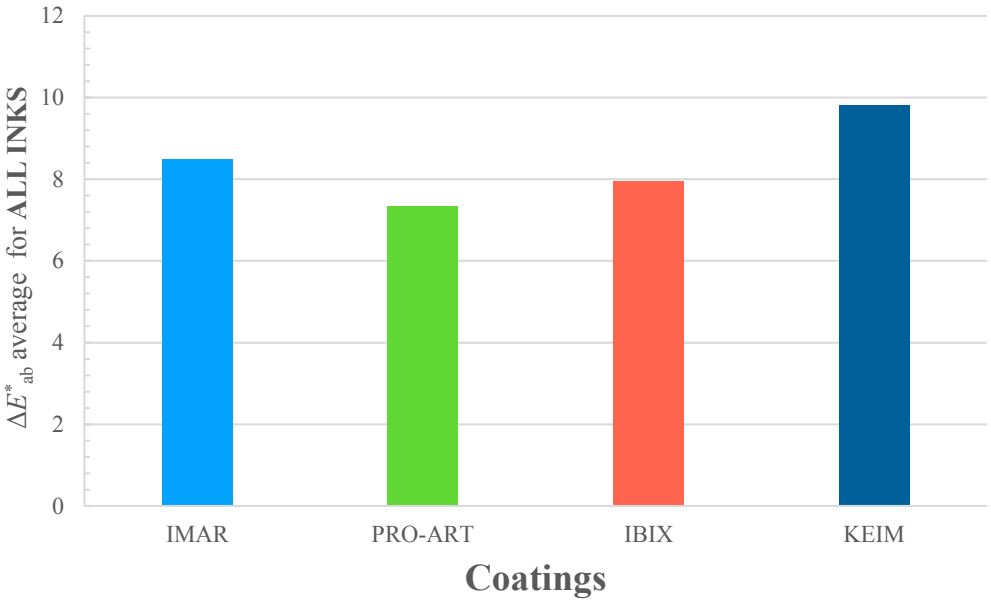

Figure 24 – Colorimetric measures average for all inks with four months applied coatings.

2.3.2. Chemical cleanings

The J.P. Teas method combined with sustainable solvents permitted to carry on the research cleaning by layers. The use of Teas method was important because the tests were performed in spray paints over an identical paint, without any protective coating, and needed an adequate level of cleaning for each paint selected, as well as the control of such operation.

The same mixtures were used for all the paints, regardless of the different formulas, as an identical method was intended for the removal of vandalism with aerosol paint.

The results obtained for the various solutions were compared for each ink and the best method or solution was selected for each one (Table 5). As can be seen on tables developed (Att. Tables 9, 10, 11, 12, 13) with identical parameters to all the solutions for most of the inks, a single solvent blends would not be effective, so it would be necessary to use a working method that could incorporate two or more solutions, depending on the thickness of the layers, to adjust this system according to the desired level of cleaning.

Table 5. Solubility tests on vandalism removal over selected paints.

		Solutions							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Inks	MTN94				✓		✓	✓	
	IVAS SP								
	LOOP	✓	✓				✓	✓	
	MNT WB				✓	✓		✓	
	IVAS SA	✓			✓	✓		✓	

Note: ✓ - solutions that presented better results.
✓ - solutions that presented good results but need control in cleaning.

For the Montana 94 ink, the solutions that presented better results were numbers 4, 6 and 7 (Att. Table 9). Solvent blends 4 showed an easy and quick solubilization of the vandalic paint without removing the chromatic layer MTN94 (Fig. Att. 11). The only negative point was the whitish appearance, resulting from the rapid evaporation of acetone (Att. Table 9). Solution number 6 showed a rapid solubilization of vandalism and a good control over the thin layers of vandalism near MTN94 without registering a chromatic difference, however the removal of the embossing associated with the substrate occurred. Solution number 7 showed low control in the cleaning of thin layers of vandalism, limiting its use to thicker layers. Advantages of its use are rapid efficiency displaced and the fact that it maintains the same optical reflection on the surface of MTN94 (Figure 25).

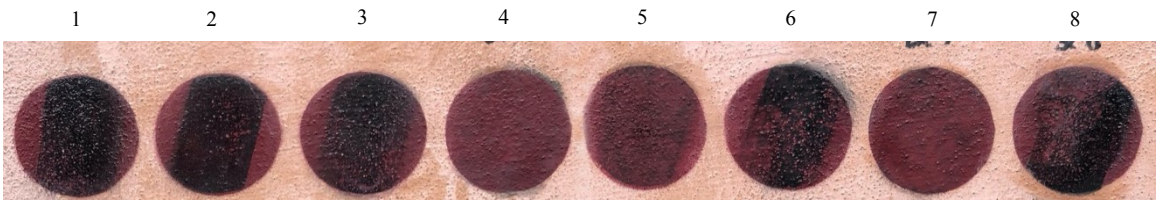

Figure 25 – Solubility tests performed on vandalized MTN94 paint.

For Ivas Superquarz Plus ink, solubility tests performed did not allow a choice of a solution suitable for a controlled removal of the surface. Solutions numbers 4, 6 and 7 (best in MTN94 solubility tests), registered a rapid solubilization of the vandalic ink but also removed the Ivas SP ink (Figure 26). Even solutions such as numbers 1, 2 and 3, which could have been more suitable for less aggressive cleaning, showed that Ivas SP ink was removed first and only then the vandalic ink. Aqueous paint compounds are known to be more sensitive to solvents used than the vandalic paint itself (Att. Table 10).

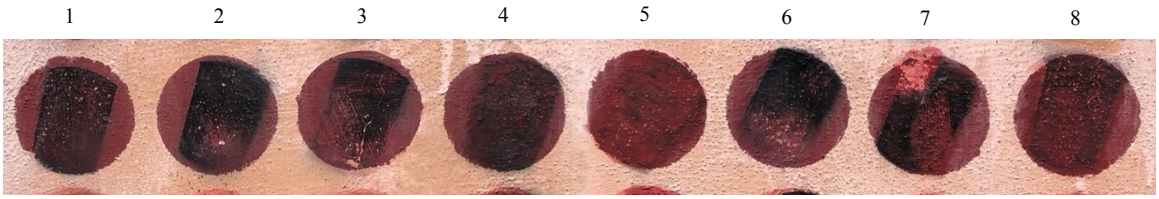

Figure 26 – Solubility tests performed on vandalized Ivas SP paint.

Regarding Loop paint tests, for thin vandalism layers, solutions numbers 1, 2, and 6 had a better performance, and for thick vandalism layers, solution number 7 was the best in tests (Figure 27). For this paint, the implementation of various solutions will have to be considered. Although solutions numbers 1, 2 and 6 did not affect the chromatic coat and resulted in a homogeneous cleaning, despite its slowest performance. Solution number 7, the one with the faster action in the tests should only be used in thick layers since when approaching the chromatic layer, dissolution begins to occur (Att. Table 11).

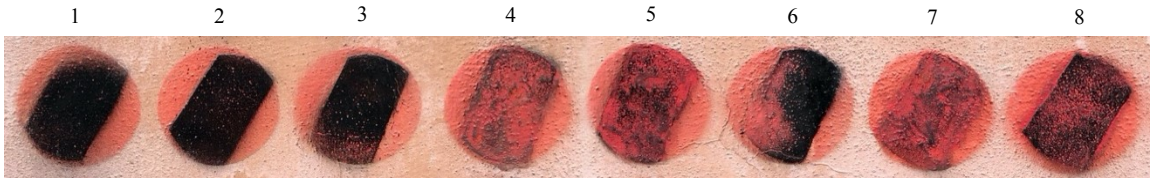

Figure 27 – Solubility tests performed on vandalized Loop paint.

The Montana Water Based paint, when compared to MTN94, showed a lower sensitivity to the solvents of solution number 4, with identical optical results, easy and quick solubilization of the vandalic paint, but also presenting whitish resulting from the rapid evaporation of acetone and removal of some embossments (Att. Table 12). Solution number 5 was slightly more aggressive than the previous one, because it rapidly removed the embossments from the chromatic surface, but it was verified that with the rolling cleaning technique it was possible to avoid this problem. Solution number 7 effectively removed the thick layers of vandalic paint, but its closeness with the chromatic layer provoked its dissolution (Figure 28).

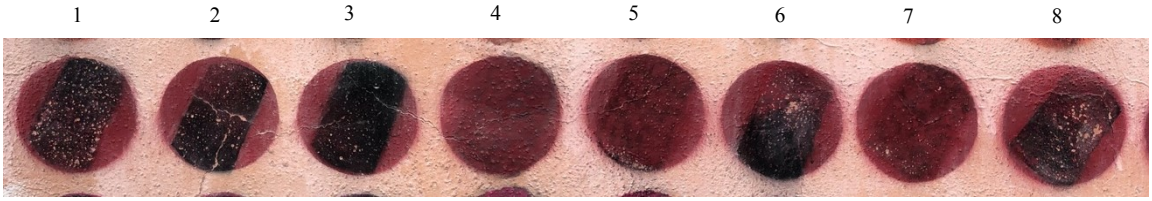

Figure 28 – Solubility tests performed on vandalized MTN WB paint.

For thin layers of vandalism on Ivas Idromatt, solution number 1 showed a controlled and homogeneous cleaning of vandalism on smooth surfaces (Figure 29). Solution number 4 showed fast results with the intensity of cleaning depending on the quantity of solvent absorbed in the cotton swab. The more solvent, the more sensitive the layer was, therefore the cotton swabs used had to contain low volumes of solvent, joining the mechanical force to the power of the solvent. The solution number 5 was slightly more aggressive, but by using the rolling cleaning technique it was possible to avoid the sensitization of the chromatic layer. With solution number 7 the rolling cleaning technique should also be used to avoid dissolution of the chromatic layer (Att. Table 13).

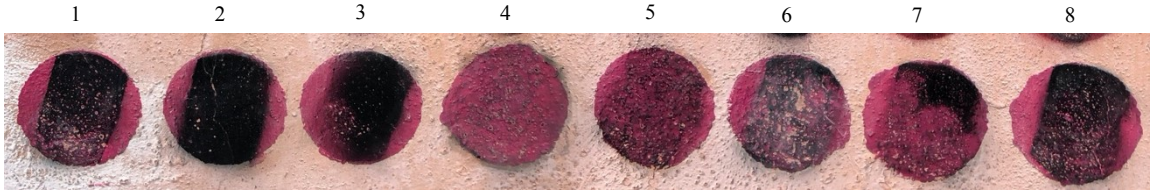

Figure 29 – Solubility tests performed on vandalized Ivas SA paint.

CHAPTER III

CONSERVATION OF MURAL PAINTING VIRTUS" BY HAZUL

3.1. MURAL WORK IDENTIFICATION

In order to apply the methodical framework of this dissertation it was planned a practical intervention on a Portuguese mural. The selected case study was the mural "Virtus", dated 2015 and whose author is Hazul, a local artist from Porto. The mural work, which is property of the *Escola Artística e Profissional Árvore,* in Porto (Portugal), is on the outside wall facing west and is of commissioned typology. It has a rectangular shape that comprises three meters high by twenty-one meters and fifteen centimeters length (Figure 30). The central female figure is flanked by floating elements contrasted by coloured geometric elements.

Figure 30 – Mural "Virtus" by Hazul, 2015.

3.1.1. Short history of *Escola Artística e Profissional Árvore*

In the early 1960s, a group of artists and intellectuals from Porto created a cultural association known as Árvore - Cooperativa de Atividades Artísticas, C.R.L., with the commitment of promoting plastic contemporary arts and an alternative cultural offer, different from the art of the *Estado Novo* regime [Salazar's dictatorship]. This group developed artistic alternatives by promoting new production processes like workshops of engraving, serigraphy and ceramics, promoting young artists with new ideas known through exhibitions and by offering different training in the most recent European plastic expressions, in a novel framework similar to the Bauhaus and Waldof movements (Árvore, 2020; Moura, 2018).

In the year of its foundation, in 1963, the institution was directed by Henrique Alves Costa and *Cooperativa Árvore*, started its activity having as first headquarter the Azevedo Albuquerque family solar that would be acquired later. Groups as "Os Quatro Vintes" formed in 68 by Ângelo de Sousa, Armando Alves, Jorge Pinheiro and José Rodrigues, and

among others like Júlio Resende, Ângelo de Sousa, Eduardo Luís, António Quadros, Rosa Ramalho, Domingos Pinho and Luís Demée (Moura, 2018) began to develop their activities contributing to the refreshment of the artistic environment (Moura, 2018).

After the revolution of April 1974, the arrival of Democracy changed the dynamism of the association now with new projects, such as the "Comissão para a Cultura Dinâmica", a project by sculptor Alfredo Queiroz Ribeiro to rethink Porto’s cultural life. To the present day, the association gained national notoriety for presenting himself as an art promotor in Portuguese creativity society (Moura, 2018).

In the 80's, these artistic activities were also encouraged because of their pedagogical perspective. Thus, several courses were outlined for the youngest, and the main headquarters were separated. In 1982, two associations arose, *Cooperativas de Ensino Artístico Árvore I* and *II*, one dedicated to superior and high school training, respectively, sharing the building of the Passeio das Virtudes[56]. In 1989 the *Escola Artística e Profissional Árvore* was created and at the end of the 90's the two cooperatives mentioned above were given different nomenclatures, the *Cooperativa de Ensino Artístico do Porto* (CESAP) for superior education, the current *Escola Artística Superior do Porto* (ESAP) and the *Escola das Virtudes - Cooperativa de Ensino Polivalente e Artístico*, C.R.L., for professional teaching, which is currently *Escola Artística e Profissional Árvore*, which now occupies the building of Passeio das Virtudes, where is Hazul mural is located, facing the Douro River (ESAP, 2020; Árvore, 2020).

3.1.2. The Artist

Walking through the streets of Porto it is possible to visualize multiple marks of artistic expression, being Hazul (1981) one of the most recurrent. Hazul considers himself, a self-taught artist and has been filling the walls of undefeated city zones with interventions since 1997. He grew up in the neighborhood of Carvalhido (Figure 31) and used to write hir name on city walls. At the age of sixteen he initiated himself in the underground culture settled in Porto, through his style (baggy clothes and cap) and his assiduous presence on hip-hop nights at the Comix Bar in Cedofeita street (David, 2017). Posteriorly he joined a

[56] Vd. Fig. Att. 48.

graffiti group with the tag Pong02 (Porto's telephone code at the time) but was given the name PZT. Until 2000 he only expressed himself with tags. After this phase, he explored the stylized and complex letters typical of graffiti, until he stopped for six years because:

> "I was simply writing my name and people didn't have to carry around with it. The only way to continue painting in the street was to think that I could transmit other things than such a selfish perspective" (Hazul in Histórias, 2017)[57]

When he stopped, he worked on figuration, which according to Capicua (2018) "was neither easy nor intuitive"[58], but which also helped him to define the metamorphosis between lettering and figuration, giving rise to a better artist (Figure 32). In 2008 he began to explore the street art movement. In that year he adopted the name Hazul, registering interventions with an expression quite far from the time of graffiti and as he said to Notícias Magazine:

> "I prefer to paint things that are not aggressive, that don't have negative connotations. I cannot paint something that incites me to anger (...) In a society bombarded with negative things, the revolutionary, for me, is to transmit harmony" (Histórias, 2017)[59].

The artistic interventions appear with a figurative character, in a symbiosis between the organic and the geometric, beings such as birds, cloaks, fish, boats, vases, crystals and faceless figures (Capicua, 2018). Strong and charged lines, stand out over occasionally floating stains with influences from primitive art, ancient civilizations, tribal people that maintain an interaction between the contemporary and ancestral world (Figure 33) portray the artist's interests and imaginary (Hazul, 2019; Capicua, 2018; Histórias, 2017). For several years he has painted in the streets while he had precarious work conditions. Later, he started to dedicate himself full time to painting in a studio in Porto downtown, embracing

[57] Original text: «Estava simplesmente a escrever o meu nome e as pessoas não tinham de levar com aquilo. A única forma de continuar a pintar na rua foi achar que poderia transmitir outras coisas que não uma perspetiva tão egoísta.» (Histórias, 2017).
[58] Original text: "não lhe era fácil nem intuitiva" (Capicua, 2018).
[59] Original text: «Prefiro pintar coisas que não sejam agressivas, que não tenham conotações negativas. Não consigo pintar uma coisa que me provoque raiva (...) Numa sociedade bombardeada com coisas negativas, o revolucionário, para mim, é transmitir harmonia.» (Histórias, 2017).

the techniques of aerosol paint, poster, stencil and serigraphy. Year after year has been being recognized and extended to galleries, individual and group exhibitions, invitations to events (Figure 34) and personal projects in Portugal as in Europe (Hazul, 2019).

Figure 31 – Mural "Mapa-Múndi" at Carvalhido Quarter for Domus Social and the City Council of Porto in January 2019 (Hazul, 2019).

Figure 32 – Artwork "Mutual" in the historical centre of Porto (Hazul, 2020).

Figure 33 – Artwork "Cápsula" in the historical centre of Porto (Hazul, 2020).

Figure 34 – Mural *at Estádio do Dragão for the 125th anniversary of F.C.Porto in 2018 (Hazul, 2019).*

3.1.3. Historical, artistic and iconographic artwork study

Dated from 2015, the artwork “Virtus” shows a stylized figuration of several natural elements, starting from a central point and spreading laterally on the outer wall of the *Escola Artística Profissional Árvore*. This wall has been used for several years by various graffiti and street art artists and this can be seen by the texture in some areas of the mural work, as well as by the various layers present in the mural work lacks. It marked the 33rd anniversary of the school, the 1st edition of Virtudes Festival as well as the personal desire

Figure 35 – Detail of the central figure of the mural work.

of the artist, who at the time was living near the installations and "dating the wall" (Árvore, Escola Artística e Profissional, 2015). The mural follows the same methodology used by the artist through a chromatic palette of bluish, yellowish and black matte tones, recurrent in the artistic phase that the author disseminated during that year, with signature in the upper right corner (Figure 36). The central element, a stylized feminine symbolic representation, similar to a Catholic Virgin Mary, but which according to the author without religious connection, captures the figurative essence of the artist, since in distinct murals he presents this figure several times, with a round faceless look and crowned with a halo. The stylized mantle that surrounds the face falls on it in a pyramidal shape with a central shaft, as if dividing the composition, developing to the sides in volutes that originate stylized figures of birds and vegetation that spread and frame a harmonious horizontal piece (Figure 35). The left end is delineated by a piece of stone, probably an old door of the building covered and through which the mural continues, represented in a volute topped by

a crystal, also a recurrent figure of the artist (Figure 37). The harmony and transmission of the mural is made through these wavy, stylized black lines in contrast to yellow, blue and grey geometric underlying elements, such as reddish floating punctuations. We are faced with a representative and positive composition of life, natural and feminist.

Figure 36 – Detail of the artist's signature.

Figure 37 – Detail of the artist's characteristic representation.

3.2. METHODOLOGY AND CONDITIONS OF ANALYSIS

3.2.1. Photographic documentation

One of the most important steps for the conservation of a mural work is its documentation. Thus, all the phases of the intervention were recorded, before, during and after the intervention. An Apple smartphone model X was used to capture the entire process. Some of the pictures taken were treated with the software Adobe® Photoshop CC 2018 to build the whole horizontal artwork, which was not feasible in a single capture [60], the same software was also used for the construction of pathology mapping. Photographs of all the details were also captured, for a detailed documentation of the mural problems and subsequently allow a better identification and understanding of the pathologies of the mural.

[60] Vd. Fig. Att. 47.

3.2.2. Optical Microscopy observation of stratigraphic sections

In order to know the thickness, the morphological characterization and the constituents of the chromatic layers, samples were taken from the various layers of the mural. As this is an invasive method, the samples were taken from discrete areas and contiguous to detachments, gaps and cracks that coincided with the various existing colors, as well as in the area of vandalism. Eight fragments of reduced dimensions were removed to be observed by optical microscopy (Figure 38) and analyzed by Fourier Transform Infrared Spectroscopy (FTIR).

Figure 38 – Sampling mapping.

An incision was made in the samples assisted with a scalpel, comprising all layers present and placed separately in 0.5 ml Eppendorfs. The samples were then divided into two parts with the aid of a binocular loupe, a scalpel and a spatula. One part of the samples was embedded in two-component of acrylic resin Technovit® 4004 for viewing in OM following stratigraphy technique standard procedures[61]. The other division of the samples

[61] The procedure comprised a mold on an initial resin base that had already been cured, with the constituent layers being placed parallel to the bottom of the mold and then the rest of the mold being filled with the same

was forwarded for FTIR analysis, without any prior treatment. Samples were observed with different magnifications under an Olympus BX51 microscope equipped with an Olympus EP50 digital camera lighted with an Olympus U-RFL-T, that allowed visualization of various layers, colour and thickness of each layer, as well the morphology of the constituent particles.

3.2.3. Fourier Transform Infrared Spectroscopy

FTIR is one of the most widely used analytical techniques in chemistry laboratories and the most common to obtain an infrared absorption spectrum to identify the functional groups of materials (Ploeger, 2012; Derrick, 1999). FTIR uses the frequency region between 4000 and 400 cm^{-1} and produces a faster spectrum than dispersive instruments (Pavia *et al,* 2015). The optical path traversed by the source energy generates an interferogram consisting of all the frequencies present in the IR spectrum. It can capture several interferograms of the same sample, thus acquiring more reliable and impartial values between the emitted signal and the noise, allowing to identify organic and inorganic materials (Pavia *et al*, 2015).

In the electromagnetic spectrum, there are vibrational transitions between the visible and microwave regions, in terms of wavelengths, between 14000 and 20 cm^{-1}, equivalent to wavelengths, between 0.7 and 500 μm (Pavia et al, 2015; Derrick, 1999), as well as rotational and translational transitions - these two being weaker. This region is divided into three parts, near infrared (NIR), mid-IR and far-IR (Derrick, 1999).

The mid-IR is the area most suitable for chemical analytics. It comprises two subgroups, the frequency region (4000 and 1300 cm^{-1}) and the fingerprint region (1300 a 500 cm^{-1}). In this quantitative process, the radiation absorbed is identical to the natural vibrations of the molecule, which allows a greater amplitude in the bonds of the molecule (Pavia et al, 2015; Derrick, 1999).

FTIR analysis was used to clarify doubts about the composition of the binders of the preparation coat and the aerosol paint applied by the artist and performed on a Perkin Elmer Spectrum 100 equipment with FT-IR Spectrometer.

resin, covering the whole sample. After curing, the samples were roughened with sandpapers of different granulometries until a cross-section of the samples was obtained.

3.3. MATERIAL AND TECHNICAL DESCRIPTION

3.3.1. Support

The wall supporting the mural is part of the infrastructure to the west of the *Escola Profissional Árvore* building. As the wall has suffered continuous acts of vandalism, artistic interventions of street art, poster, and stickers it presents a thick layer of materials up to the infrastructure (Fig. Att. 49 and 51). It was not possible to identify the support, so it was assumed to be identical to the interior walls in stone masonry with regular joints aligned.

The area to the left of the building, which would be a service door of the old building, could probably be in cement block masonry, plastered and painted with an aqueous exterior paint.

3.3.2. Preparation layer

The mural presents a white layer of industrial exterior paint applied by the owner. This preparation layer combines two constructive phases of the mural, on the one hand, the preparation of the wall with the coverage of the whole area in order to receive it, and on the other hand, a background layer used by the artist. It was possible to verify through gaps and stratigraphic layers that this white layer was placed by superimposition to previous manifestations of graffiti and street art [62]. The composition of the paint used shows calcite as one of the compounds, revealed by FT-IR [63] and in comparison, with spectra of the same type (Cortea, 2020; Macchia *et al,* (2019a). The paint was applied by brush, confirmed by the texture of the surface and the appearance of bristles punctually across the surface.

3.3.3. Chromatic layers

The aerosol paint technique was used for the execution of the mural[64]. According to the author, the solid and low gloss colour palette was executed with NBQ Pro® aerosol

[62] Vd. Vd. Fig. Att. 49 to 55.
[63] Vd. Fig. Att. 57, 59 and 60.
[64] Vd. Video of Árvore, Escola Artística e Profissional (2015) about the construction process of the mural.

paints, on top of the white layer previously placed[65]. This paint is an aerosol paint with butane and propane propellant, with ethyl acetate solvent and alkyd binder. It has a fast-drying formula, good flexibility, good abrasion resistance, good adhesion to any surface, and doesn't containing heavy metals, presenting good resistance to weather changes and to UV light, quite identical to the studied MTN94 ink. The data sheet of this ink was supplied by Dedicated Store in Porto and confronted with the FTIR spectra, which confirmed the alkyd binder[66].

Samples taken from chromatic layers were visualized by OM and have multiple thicknesses (between 0,1 mm and 0,10mm)[67]. These are opaque, homogeneous, smooth layers, without brush strokes, as the artist only used aerosol paint. The chromatic palette representing the author's artistic phase in 2015, was identified with the colours[68]: N50 Black, N152 Pure Red, N42 Menhir Gray, N41 Allergic Gray, N61 Ride Yellow, N15 Calimocho Red, N85 Plastic Blue and N87 Tide Blue.

3.3.4. Posterior interventions

The mural presents several repaints executed by the artist. Shortly after its execution, the work was vandalized in the central zone throughout its extension with a black and blue aerosol paint. The same industrial paint was not used in the white preparation coat, but a white aerosol paint from NBQ Pro®, with the reference N01 White, as described by the author. The other chromatic zones submitted to vandalic acts were repainted with the same set of paints described in the point 3.3.3. In some areas of the white layer it is possible to see partially visualized blue and black vandalic paint through its transparency [69].

[65] Vd. Fig. Appx. 2.
[66] Vd. Fig. Att. 61.
[67] Vd. Fig. Att. 50, 52, 53, 54, 55, and 56.
[68] Identified by the Dedicated Store in Porto, where the artist bought the paints and referred that in the same shop, they would know which one he had used.
[69] Vd. Fig. Att. 81.

3.4. Conservation Condition

3.4.1. Support

The support is in a good conservation condition, presenting structural stability without loss of cohesion and displacement of mortar layers.

The mural has longitudinal fissures which coincide with the joints of the upper stone friezes with extension to artwork center. Being a west-facing wall does not receive direct sunlight, so there is descending humidity in the upper areas of the mural with greater intensity at the edges as recorded in the map of pathologies (Fig. Att. 62).

3.4.2. Preparation layers

The preparation layers show several pathologies, directly connected with the location of the mural. The surrounding area presents vegetation of deciduous trees and is an area as intense traffic circulation, as well as a place where people pass through frequently. These factors lead to the propagation and accumulation of dust and dirt that adhere to the west-facing surface, and which by the accumulation of humidity form dirty films that serve as a nutritional source for biological agents, namely microalgae and lichens, present throughout the mural (Fig. Att. 66, 67). Located in urban area not far from the Douro river, it also presents traces of macro organisms like seagulls which droppings progressively release uric acid and corrode the chromatic layer (Fig. Att. 68). These pathologies are more present and evident in the white layer because it is more porous than the aerosol paint applied by the artist.

Longitudinal cracks are present too and they run vertically over the surface. Several detachments and gaps that reveal the red layer underneath or layers of previous street art interventions, caused by humidity fluctuations, consequently, catalyze the degradation of the plasticizing agents (Fig. Att. 63 and 64).

It also shows ferrous oxidation run-off from the water meter compartment (Fig. Att. 70), and vandalized areas by human action involving a chemical degradation from a burnt area (Fig. Att. 69), application of black aerosol paint (Fig. Att. 71) as well as a permanent orange marker on the water meter compartment cover (Fig. Att. 90).

3.4.3. Chromatic layers

The chromatic layers with aerosol paint show various pathologies, due to exposure to meteorological agents as well as human and animal actions. These pathologies correspond to small longitudinal cracks, gaps and aggravated detachments that form air pockets in the chromatic layers, caused by fluctuations of humidity and low or high temperatures that increase the mobility of the polymeric compounds and harden the chromatic film leading to progressive detachment (Fig. Att. 72, 74, 75 and 76). The surface dirt, less adhered in the preparation layer, is also noted because the aerosol paint is more plastic and less porous. In this paint the bird excretions have provoked a more severe degradation action than in the white preparation layer (Fig. Att. 77).

The presence of vandalism from human agents in the form of black aerosol paint in the colours blue, red, grey and black, representing the letters G and B (Fig. Att. 73) is visible and presents an alkyd resin as one of the compounds, as revealed by FT-IR[70]. The presence of two small stickers in black and blue elements of the work (Fig. Att. 75) and a burnt area in the blue, black and red are also visible.

3.4.4. Posterior interventions

The artist's aerosol paint repaints are considered stable. It is possible to see the difference between the areas that have repaints and those that maintain the original layers, since the texture registers a flatter surface, a different optical reflection, of a more vibrant colour (Fig. Att. 78 to 81). These layers are occasionally detached from the white layer, probably caused by incompatibility of materials.

These repaints were also targets of the second vandalism with a black aerosol paint and a permanent orange marker.

[70] Vd. Fig. Att. 58.

3.5. Conservation Treatment

3.5.1. Readhesion of chromatic layers detachments

The readhesion of chromatic layers was made by using a synthetic acrylic adhesive, Plextol B500. This procedure was performed with ethyl alcohol, which functioned as a tensioactive agent, allowing a better impregnation of the adhesive on the detachments by reducing the contact angle and consequently reducing the surface tension of the adhesive. The procedure was applied by injection for a better distribution and adhesion of the layers and whenever possible, taking the advantage of the gravity force. This process was carried out in stages, since these detachments covered large areas and it was impossible to repair them in a single application. The first phase was carried out with a 15% dilution of the adhesive in distilled water, from the upper area of the mural to the lower area, in order to reach, through gravity, the air pockets that ran along the surface. This procedure was followed by the use of a semi-rigid sponge to make some pressure in order to seal the joints (Fig. Att. 82). In a second phase, the adhesive was diluted 50% in distilled water to repair the remaining detachments. The union was also made with the semi-rigid sponge and a semi-flexible spatula, depending on the dimensions of the detachments (Figure 39). In the thicker areas of the chromatic layers the adhesion was only achieved by applying the adhesive in its original formula, and it was also made with a semi-flexible spatula and the semi-rigid sponge (Fig. Att. 83).

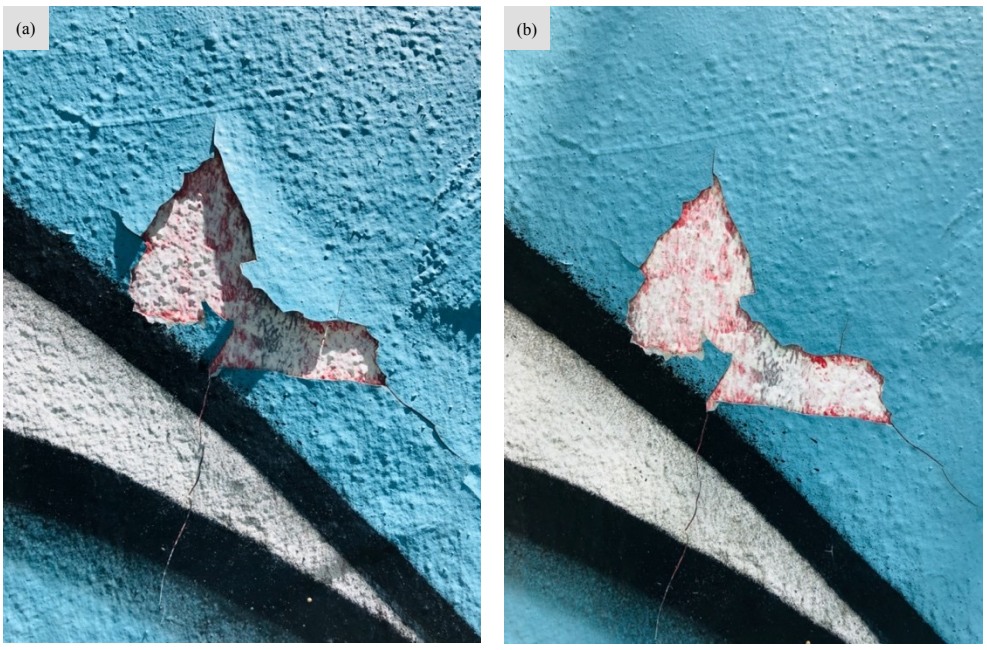

Figure 39 – Detachments in the lower right area of the work: a) before intervention; b) adhesion with Plextol B500 dispersed at 50% in distilled water.

3.5.2. Surface cleaning

Due to the spread in the entire mural of the of microalgae, lichen, dust, pollutants and bird droppings it was necessary to carry out a general cleaning towards to eliminate the most adhered dust and dirty. Tests were carried out with a neutral detergent diluted at 2% in distilled water (Neutracon) in discreet areas of each colour. The cleaning process started from the left to the right of the wall, in vertical strips, from the upper to the lower area, using a container with the neutral solution and another with tap water for the removal of the neutral detergent residues, changing them occasionally when they became saturated with dirt (Figure 40). This action was performed with the support of soft sponges, which also allowed the friction on the chromatic surface without altering or damaging it (Fig. Att. 84). In this cleaning it was also possible to remove the two stickers adhered to the work, by softening and rubbing the adhesive with the soft sponge (Fig. Att. 85).

Figure 40 – Surface cleaning with neutral detergent: a) before intervention; b) after the cleaning.

3.5.3. Vandalism removal

For the chemical cleaning of vandalism, solutions number 4, 5, 6, and 7 studied in Chapter II in points 2.2.4 and 2.3.2 were tested in areas where vandalism was present. The entire cleaning process was carried out with cotton swabs. The tests allowed us to conclude that the most sensitive colours were the aerosol red, grey (shadow given by the artist under the industrial white paint) and the white preparation layer. For the grey and white colours, solution number 5 was used to remove the thickest layer and solution number 6 to remove the thinner layer of vandalic ink. This removal was made with cotton swabs in circular movements, resulting in a uniform cleaning. In certain areas it was necessary to keep vandalic ink residues because the underlying layer was sensitive (Fig. Att. 88 and 89). In the red colour the removal was only possible with the solution number 7 using rolling movements, because the layer was easily solubilized, so it was only possible to pass the cotton swab once, leaving some residues of vandalic ink black, which do not affect optically the visualization of the painting (Figure 41).

Figure 41 – Vandalic aerosol paint on red layer: a) before the intervention; b) after the cleaning.

The other colours of the aerosol paint - grey, blue and black – were cleaned with solution number 7, with swabs in circular movements, without damaging the chromatic layers. In the grey colour, part of the vandalic paint had penetrated the pores and it was

impossible to remove it, observing a contour line (Fig. Att. 87). The blue colour penetration of the vandalic paint was not observed, and a uniform cleaning was obtained by leaving no trace of residues (Fig. Att. 86). In the black paint, a partial cleaning was performed on the vandalic paint until an identical optical reflection was obtained, because the approach to the original chromatic layer could not be perceived. This intervention is not perceptible from a certain distance and fits in the totality of the artwork reading and perception, as can be seen in Figure 42.

The vandalism performed with an orange marker in the water meter compartment was also removed through solution number 7, with cotton swabs in circular movements, resulting in a homogeneous cleaning. However, at the edge orange paint was still lodged in the pores of the white industrial paint, but without aesthetically affecting the mural (Fig. Att. 90 and 91).

The burnt area was attenuated with ethanol applied with cotton swabs in circular movements, which resulted in uniform cleaning, but still presenting a yellowish surface. The risk of insisting with a deeper cleaning with this solvent would cause the dissolution of the chromatic layer and didn’t allow a total removal (Fig. Att. 92 and 93).

Figure 42 – Chemical surface cleaning: a) before intervention; b) after the cleaning.

3.5.4. Oxidation removal and biocidal application

The presence of active corrosion derived from the water compartment and which flowed into the white chromatic layer were removed with EDTA (ethylenediaminetetraacetic acid) dissolved in 5% of distilled water and applied through a cellulose pulp poultice for 10 minutes in two applications (Fig. Att. 94 and 95). The following procedure consisted in the application of an oxide converter to the water compartment area and a final coating of tannic acid (CCI Notes 9/5, 2019) diluted in 5% ethyl alcohol. This gives a protective film on the metal surface, creating a stable organometallic complex.

As a biocide we selected to apply Ethyl alcohol (Fig. Att. 96), an aliphatic organic solvent (Peacock et al, 2014; Ingram, 1985) in order avoid the new development of microalgae and lichen in the exposed chromatic layer. This was applied from left to right, from the upper zone to the lower with a soft bristle brush, with little pressure, towards to not alter the chromatic surface, mainly the red colour, which is the most vulnerable to this solvent.

3.5.5. Protective coating application

After the biocide application the protective coating was applied[71]. The chosen coating was based on the tests carried out in Chapter II in points 2.2.3 and 2.3.1. According to the study, the coating with better performance for the chromatic layers and as best solution against vandalism was the Pro-Art coating (Fig. Att. 97 and 98). This product was applied from left to right with a soft bristle brush, from the upper zone to the lower zone. During this treatment we avoid the run-off and accumulation of the coating by controlling the quantity in the wetting of the brush and applying quick strokes and in all directions, so as to place the coating evenly over the entire surface.

[71] In this last phase of the intervention only the protective coating was applied, where the volumetric and chromatic reintegration of the work was excluded because it was not necessary for the reading of the artwork, as well as the physical and chemical stability of the work. With this intervention a curative conservation was intended, Fig. Att. 99 presents an overview of the work after the intervention.

3.6. Preventive Conservation Measures

Preventive conservation aims to achieve a set of direct and indirect actions intended for the correct practice in the preservation of works of art, encompassing the proper and continuous inspections of the state of conservation condition, in order to ensure the stability, the endurance and enjoyment of the work over time (Back, 2019; Camacho, 2007).

It is advisable to create a maintenance plan with cyclical inspections of procedures with measures to ensure that the rhythms of degradation are minimized, so that the appearance of new pathologies can be precociously detected and properly treated at an early stage, in order to avoid more intrusive interventions (Rainer, 2003).

The preservation of a work is directly influenced by the place where it is located, being even more important in an outdoor piece, conditioned by both atmospheric and human factors.

The mural is located in the historical urban context of Porto, where the weather conditions are characterized by an Atlantic climate region. Located in a high area of the city and adjacent to the coast and close to the river, it is affected by winds blowing from the northwest with an average speed of 20 to 25 km/h (5.5ms/s to 6.9 m/s) affecting the mural through the displacement of pollutants and dust. With the annual increase in temperatures, the city has been registering average temperatures between 12ºC and 19ºC, and with an average precipitation of 1200 mm per year, which relate and act directly on the mural, triggering phenomena of progressive degradation in the polymeric compounds of the paint in aerosol. Regarding to pollutants and contaminants, the increasing flow of tourism in the area of Passeio das Virtudes, does not directly affect the mural. Although the surrounding area presents a high risk of air degradation namely in Miragaia parish, that suffers the negative effects of pollutants emitted by traffic (CNPC, 2019; CIBIO-InBIO, 2018).

The biological contamination present through the proliferation of tree spores and plant roots is more severe in the upper rim and the surrounding walkways that promote cracking and contamination by microorganisms is also present. The assiduous presence of flying birds, such as seagulls and pigeons also directly affect the mural, since their excretions are acids and promote chemical corrosion of the chromatic layers (Fernández Arcos, 2019).

In order to safeguard the work, the institution should create a six-monthly cleaning plan with neutral detergent and the use of soft sponges, the placement of a dissuasive system against birds, good maintenance of the surrounding area and a the careful and frequent cleaning to avoid the accumulation of waste in the surrounding area (Rainer, 2003; Camacho, 2007).

In addition to these atmospheric agents the mural is vulnerable to human action being possible for anyone to interact with the mural "Virtus". Thus, safeguard plan should include the maintenance of the painting by caring out vandalism traces thought re-application of protective coating. Pro-Art has a durability of approximately one decade when not altered by human action, being necessary a new application after this deadline.

FINAL CONSIDERATIONS AND FUTURE RESEARCH PROSPECTS

Conservation of urban art murals is a complex subject and requires a significant share of information between conservators, artists and other agents. The context of the artwork will always be relevant in conservation of urban art, as well different perspectives regarding what is the best approach from both conservator and the artist.

Historical contextualization has also become relevant because allows for an understanding differences between emergent movements, which depending on the place, present certain influences. In Portuguese and Italian cases, for example the movement appears in different decades and with different perspectives. On the one side, Portugal at the beginning experienced a trend of freedom associated with the end of dictatorial regime and a slowly spreading with Internet arrival and media. On the other hand, Italy registers propaganda influences from exiled Chilean, as well as absorbs New York trends carried by cultural agents, who promoted a series of exhibitions. These movements may on the one hand be quite similar, as they present a politicized context, but on the other hand, the Italian expositive impulse led to a different perspective in musealization of urban art, by an early focus on maintenance and conservation projects for urban art. This is far from the Portuguese perspective, where urban art galleries are the result of artworks made in exhibition sites or in artist's studios.

The research on protective coatings, as well as the study of chemical cleaning solutions on vandalism, have proved to be of great interest as new working methods were developed and evaluated for coatings, with the main objective being to evaluate the applicability and protection to urban art murals. Results obtained showed that coatings didn't penetrate in the chromatic layers ass seen in Zn samples visualization, but colour variations occurred as quantified by colorimetric analysis. These colorimetric differences showed higher values in coatings with Loop ink. Considering the different values obtained for all inks and coating wetting, it was observed that Pro-Art coating changed the least during the four months of research and is the one that is best suited as a vandalization limitation after two coating applications on specimens, resulting in a good hydrophobic surface. For future work temperature and relative humidity variations studies to compare with existing data would complement the data obtained.

The study on cleaning agents also added value for conservation as it determines, within the available market products wide range, the most suitable and sustainable agents for murals works. The methodology used has shown that there is not a single solution suitable for all the selected materials. On different vandalic ink thickness and different selected ink of the murals, the formulations created worked effectively in alkyd binder inks (MTN94 and NBQ Pro), as well as in altered PU binder ink (MTN WB). For future work it would be interesting to apply these solutions in semi-rigid supports, such as hydrogels, when compared with free solvents and evaluate for a more uniform and controlled cleaning procedure.

As regarding the *in situ* intervention of "Virtus" mural, optical microscopy and FTIR analysis made it possible to verify and identify which materials were used by the artist, as well as to guide conservation intervention, incorporating both the protective coatings and cleaning agents' research previously done. The mural was in a poor condition, mainly due to detachments and air pockets between chromatic layers and support, as well as vandalism with aerosol paint. An intervention methodology was elaborated that allow a better reading, while also promoting constituent materials stabilization.

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ATTACHMENT I

STAGES OF CONSTRUCTION OF SPECIMENS AND SELECTION OF TEST AREAS

CONSTRUCTION LOCATION OF THE SPECIMENS

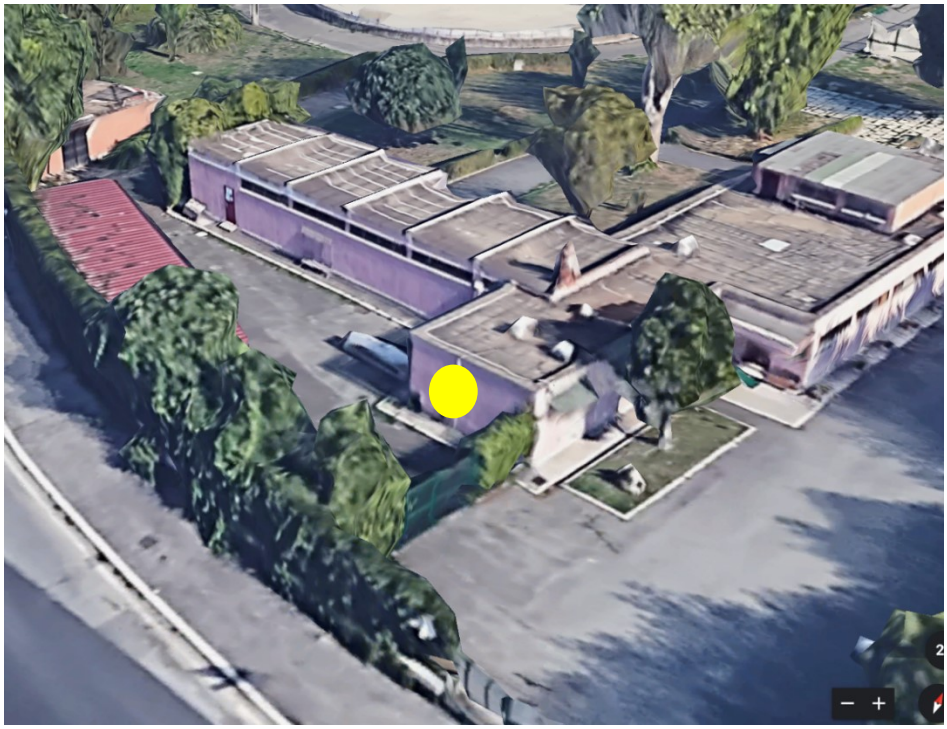


Fig. Att. 1 – Yococu laboratory in Via delle Tre Fontane in Rome (ext. Google Earth).

Fig. Att. 2 – Construction of the specimens, a) stencil model, b) application of spray ink, c) application of ink with brush, d) specimens finished.

SPECIMENS SELECTION AREAS FOR THE INVESTIGATION

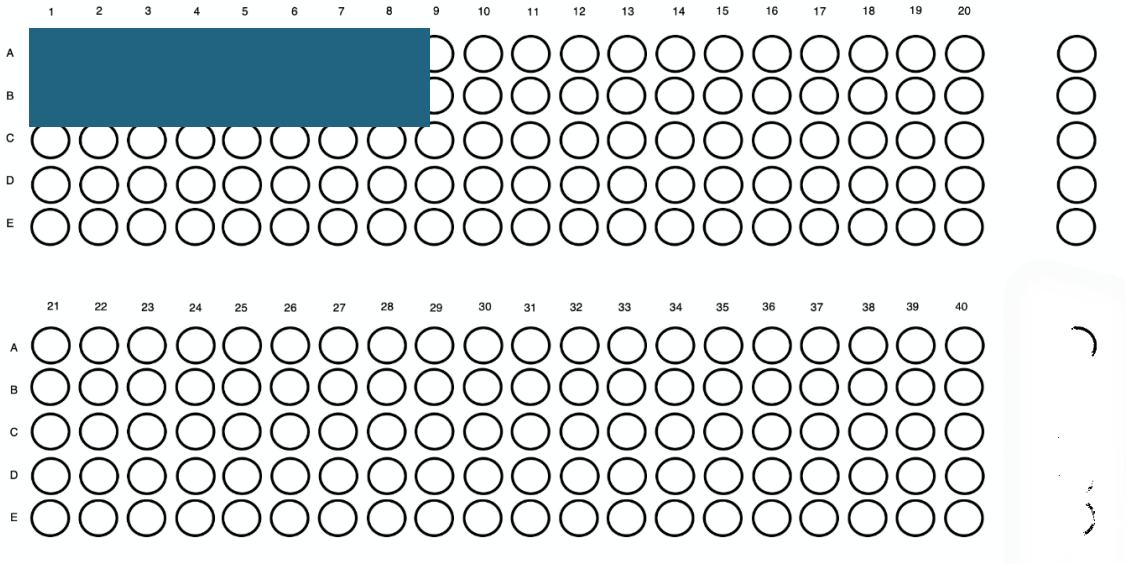


Fig. Att. 3 – Location of used specimens for protective coatings tests for OM and SEM/EDS marked with TiO2.

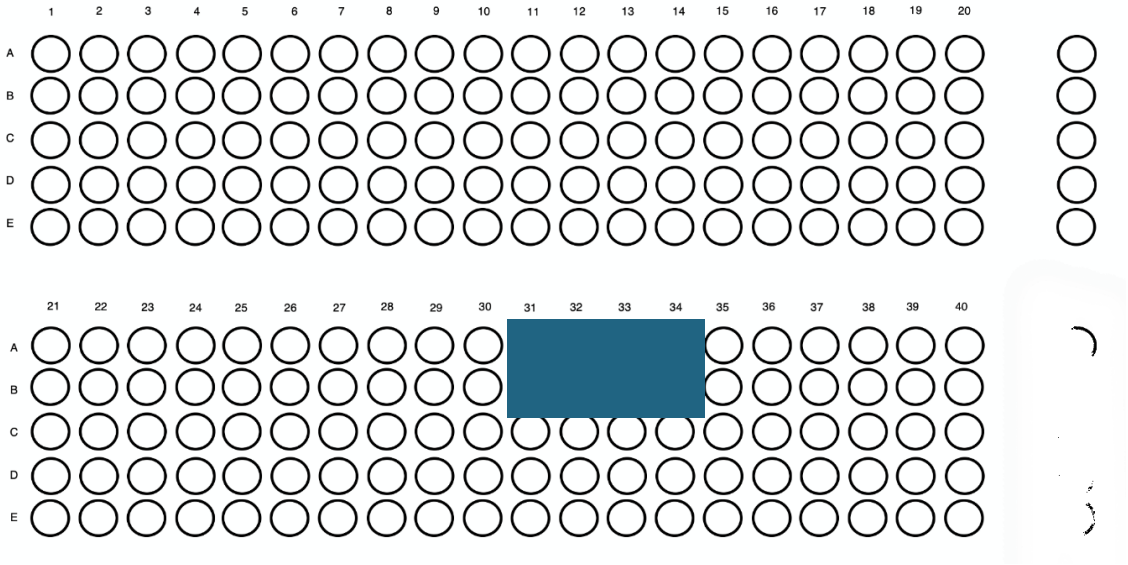


Fig. Att. 4 – Location of used specimens for protective coatings tests for OM and SEM/EDS marked with Zn.

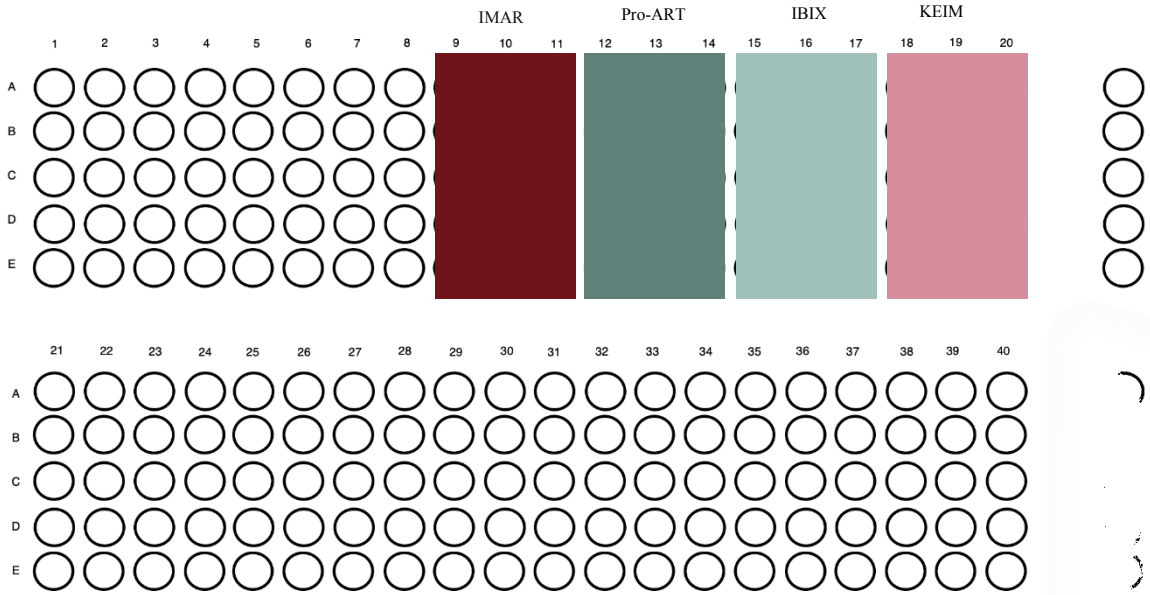


Fig. Att. 5 – Location of specimens for protective coatings tests.

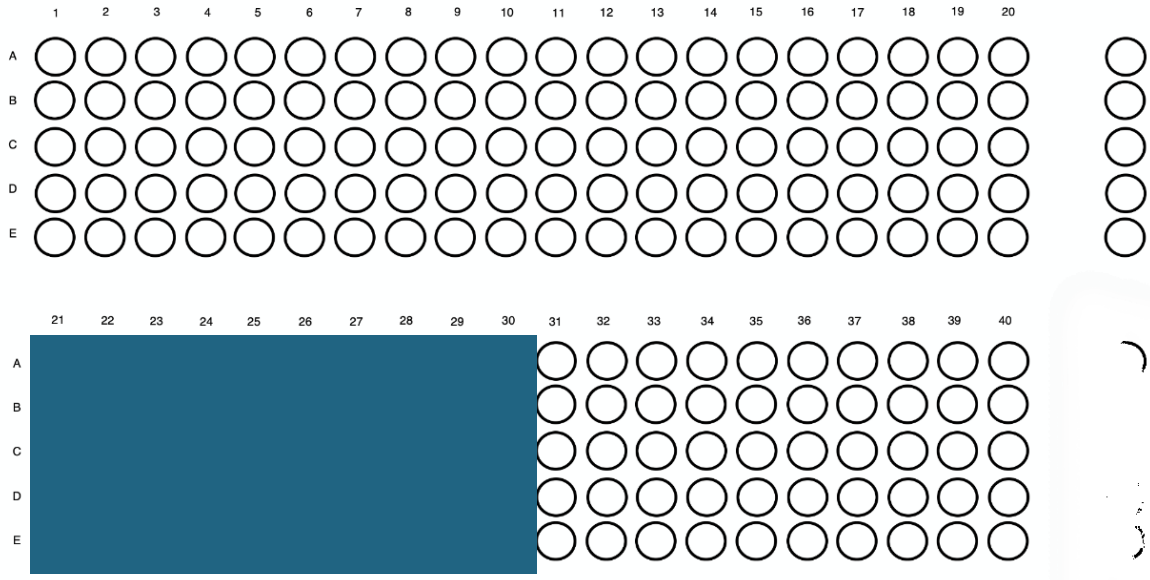


Fig. Att. 6 – Specimens used in cleaning research.

ATTACHMENT II

METHODOLOGY APPLIED TO PROTECTIVE COATINGS AND CLEANING AGENTS

Visual Exams of the applicability of coatings in the selected inks

Table 6. Applicability of protecting coatings over all selected inks: MTN94, Ivas SP, Loop, MTN WB and Ivas SA. The description on the applicability of the protective coatings on a paint shows the same results for the selected inks.

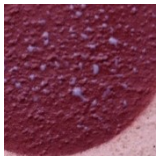
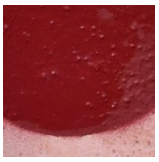
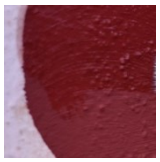
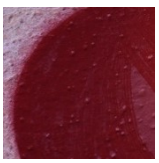
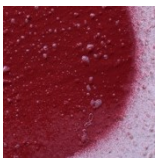
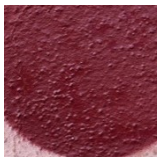
	MTN94	IVAS SA	LOOP	MTN WB	IVAS SA	
IMAR						- High surface tension, with the formation of drops. Difficult spreading of the coating layer. Whitish in application, which disappears during drying.
PRO-ART						- Homogeneous spreading on the surface, without formation of drops, but with hydrophobic action on the surface.
IBIX						-Foam formation, derived from a surfactant compound in the formula, which results in irregular spreading over the surface.
KEIM						- Even spreading. Milky colour and glossy. Brush stroke over semi-dry area drags, making a layer easy to disintegrate.

Table 7. Average of saturation and dispersion of a second layer of protective coating. Scale from + (bad) to +++ (very good).

		Protective Coatings			
	Inks	IMAR	PRO-ART	IBIX	KEIM
A	Montana 94	++	++	+	++
B	Ivas SP	++	-	++	+++
C	Loop	+++	+	++	+++
D	Montana WB	+	++	+	++
E	Ivas SA	+	++	++	++

VISUAL EXAMS OF THE APPLICABILITY OF COATINGS TESTS FOR OM AND SEM/EDS MARKED WITH TiO_2.

Fig. Att. 7 – Percentage tests for marker used in coatings, TiO_2, for SEM/EDS analysis.

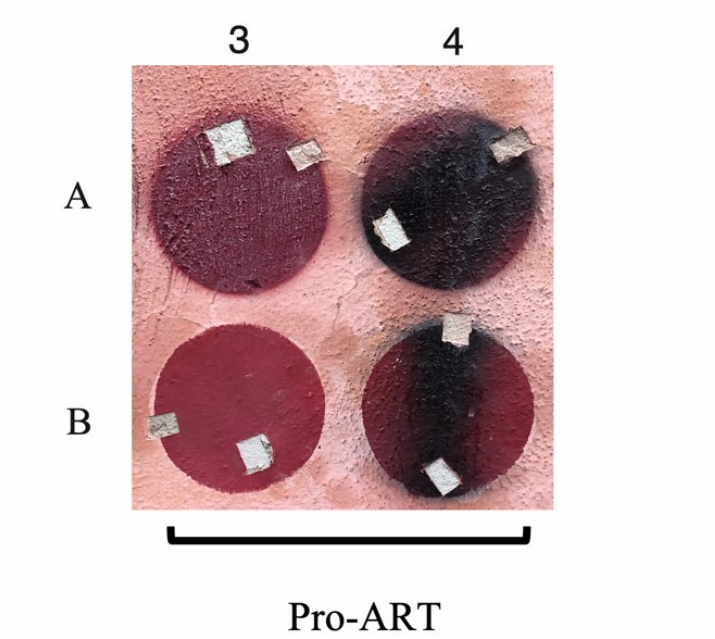


Fig. Att. 8 – TiO_2 samples collection for second SEM/EDS analysis.

CONTACT ANGLE EXPERIMENT BY TYPE OF INK

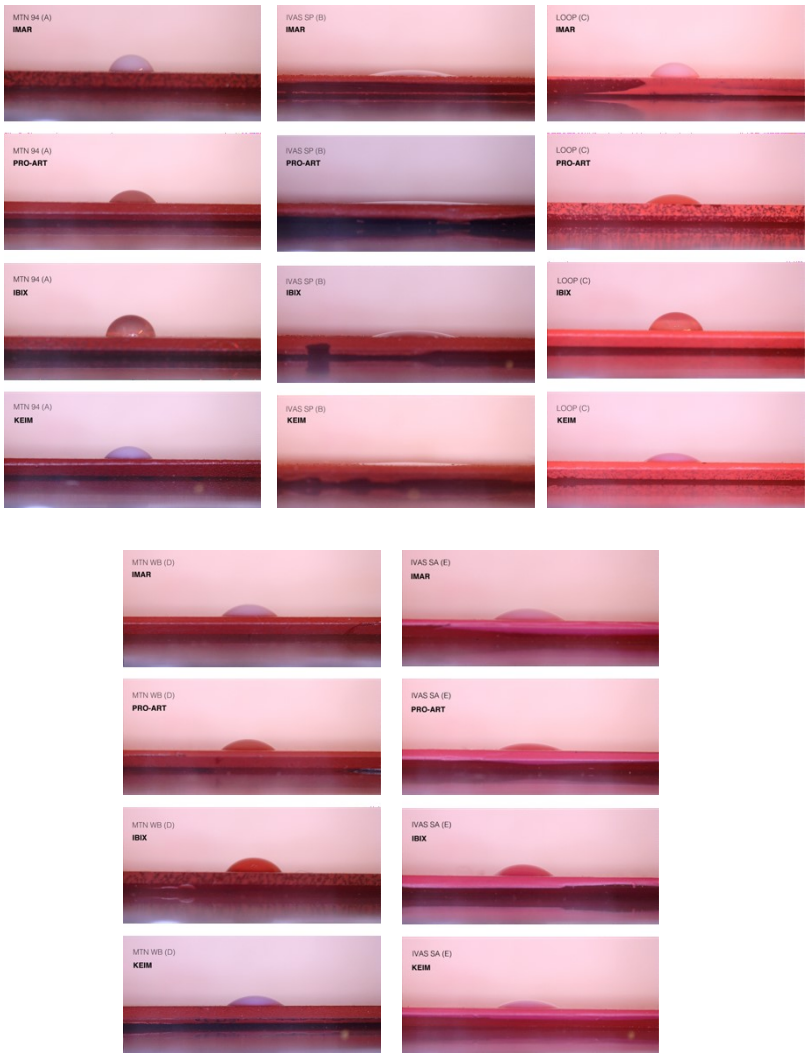


Fig. Att. 9 – Contact Angles of protecting coatings over all selected inks: MTN94, Ivas SP, Loop, MTN WB and Ivas SA.

Table 8. Solubility system through the forces of dispersion (fd), polar (fp) and hydrogen (fh).

Solvents	**fd**	**fp**	**fh**
2-MeTHF	64	18	18
DBE - LVP	55	14	31
Water	21	22	57
Acetona	47	31	21
Etanol	39	14	47

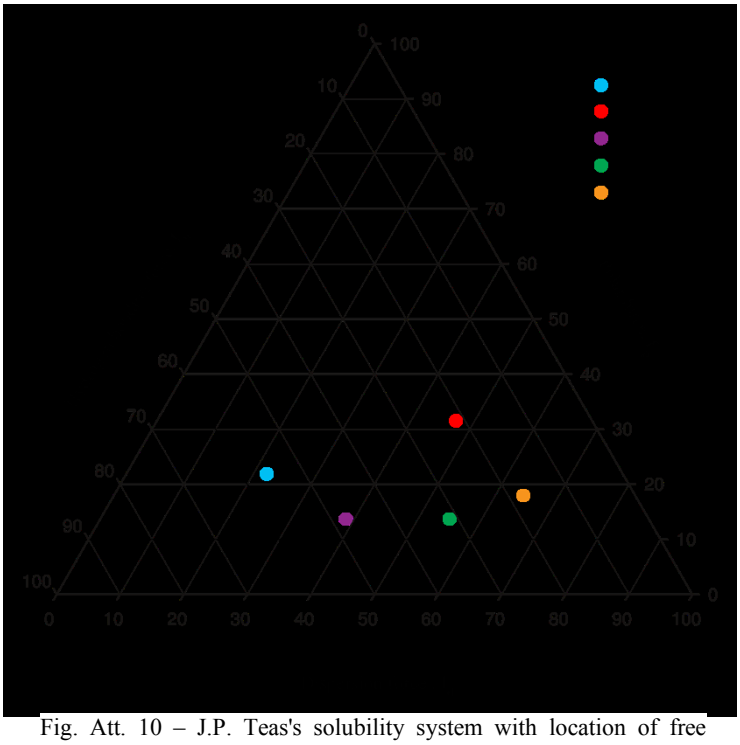


Fig. Att. 10 – J.P. Teas's solubility system with location of free solvents.

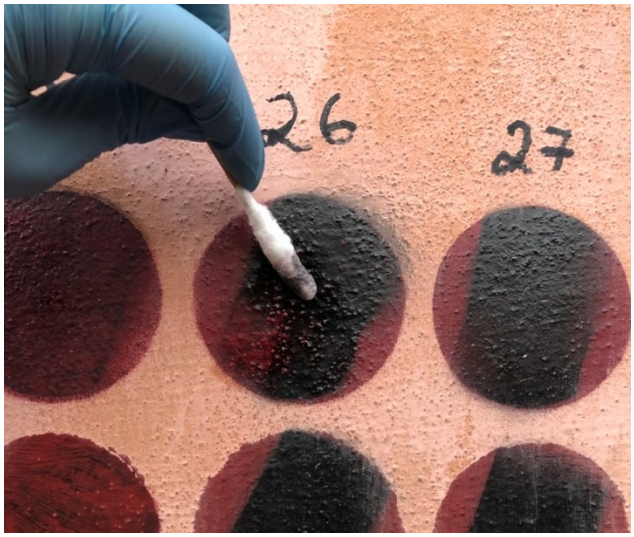


Fig. Att. 11 – Vandalism cleaning test on Montana 94.

Table 9. Solubility tests on vandalized specimens with Montana 94.

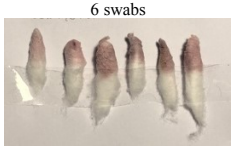
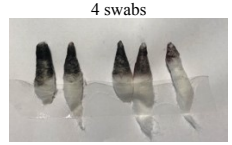
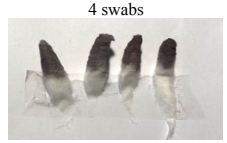
1	2	3	4	5	6	7	8
Swab rolling test (beginning of solubilization):							
65 s.r.t. without results	85 s.r.t.	100 s.r.t. without results	2 s.r.t.	2 s.r.t.	20 s.r.t.	2 s.r.t.	100 s.r.t. without results
Solvent action (min. +; max. +++) | Amount required to remove vandalism paint:							
+	+	+	+++	++	++	++	++
5ml	2ml	5ml	3ml	2ml	4ml	3ml	2ml
Aggressiveness:							
+	+	+	+++ without removing chromatic layer	+++	++	++ without removing embossing	++
Efficiency evaluated on the solvent power and on its management:							
+	++	+	+++	++	+++	+++	++
Number of swabs to remove vandalism ink:							
6 swabs 	3 swabs 	5 swabs 	3 swabs 	3 swabs 	5 swabs 	4 swabs 	4 swabs 
Time needed to remove vandalism ink:							
8min - incomplete	9.07min	8.25 min	3.40 min	4.07min	6.07min	5.28min	5.36min
- whitish the chromatic layer; - with pressure cleans better; - removes the embossing; - uncontrolled as you approach the bottom layer.	- homogenous cleaning; -removes part of the chromatic layer; - uncontrolled as you approach the bottom layer; - with pressure cleans better.	- very slow; - removes chromatic layer right away; -removes only with pressure.	- whitish the chromatic layer - removes very well the embossing; - removes without pressure - fast action.	- good for thick layers; - rolling cleaning; - pressures removes de chromatic layer.	- removes the embossing; - controlled as you approach the bottom layer; - without penetration the chromatic layer.	- good for thick layers - rolling cleaning in thin layer - without whitish the chromatic layer	- homogenous cleaning ; - removes the embossing; - whitish the chromatic layer.

Table 10. Solubility tests on vandalized specimens with IVAS SP.

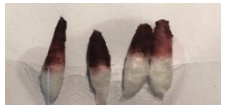
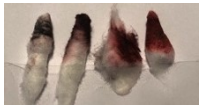
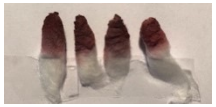
1	2	3	4	5	6	7	8
Swab rolling test (beginning of solubilization)							
82 s.r.t. without results	92 s.r.t. without results	100 s.r.t. without results	4 s.r.t.	4 s.r.t.	22 s.r.t.	5 s.r.t.	
Solvent action (min. +; max. +++) | Amount required to remove vandalism paint							
++ 4ml	+ 3,5ml	++ 3ml	+++ 1ml	+++ 3ml	++ 2ml	+++ 5ml	
Aggressiveness							
+	+	+	+++	+++	++	+++	
Efficiency evaluated on the solvent power and on its management							
++ Plain surface	+	++	++	+	+	+	
Number of swabs to remove vandalism ink							
5 swabs 	4 swabs 	6 swabs + 1 buffer 	2 swabs 	4 swabs 	2 swabs + 2 buffers 	2 swabs + 1buffer 	4 swabs 
Time needed to remove vandalism ink							
6.48 min – incomplete	6 min	7.27 min + 5min	2 min	3.39 min	2 min + 10 min	2 min+10 min	min
- whitish the chromatic layer; - with pressure cleans better; - removes the embossing and the chromatic layer dragging the vandalism; - uncontrolled as you approach the bottom layer.	- removes the embossing; - removes part of the chromatic layer; - uncontrolled as you approach the bottom layer; - penetration of the chromatic layer, sensitive.	- very slow; - removes chromatic layer right away; - removes only with pressure; - removes the embossing and the chromatic layer dragging the vandalism.	- uncontrollable, fast action; - removes chromatic layer right away; - removes all chromatic layers; - removes the embossing and the chromatic layer dragging the vandalism. - easier to clean then the MTN94.	- good for thick layers; - affects the chromatic layer dragging the vandalism; - chromatic layer very sensible to the solution.	- removes the embossing; - penetration the chromatic layer; - sensible.	- penetration into the chromatic layer; - removes the embossing and the chromatic layer dragging the vandalism; -very sensible.	

Table 11. Solubility tests on vandalized specimens with Loop.

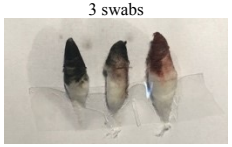
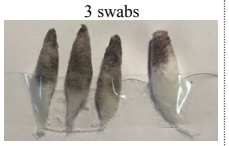
1	2	3	4	5	6	7	8
Swab rolling test (beginning of solubilization)							
100 s.r.t. without results	54 s.r.t.	100 s.r.t. without results	2 s.r.t.	2 s.r.t.	63 s.r.t.	3 s.r.t.	17 s.r.t.
Solvent action (min. +; max. +++) | Amount required to remove vandalism paint							
+ 3ml	+ 3ml	+ 3ml	+++ 4,5 ml	+++ 2,5ml	++ 2ml	+++ 2ml	+++ 5ml
Aggressiveness							
+	+	+	+++	+++	+	++	+++
Efficiency evaluated on the solvent power and on its management							
++	+++ thin layer	+	++	++ thick layer	+++ thin layer	++ thick layer	+
Number of swabs to remove vandalism ink							
3 swabs 	4 swabs 	4 swabs 	4 swabs 	3 swabs 	3 swabs 	3 swabs 	4 swabs 
Time needed to remove vandalism ink							
10 min	10.45min	9min	4.26min	3.09min	7.41min	4.54 min	3.40min
- with pressure cleans better; - good for thin layers; - doesn't interact with the chromatic layer; - homogenous cleaning.	- slow cleaning; - good for thin layers; - removes the embossing; - doesn't interact with the chromatic layer.	- removes the embossing and the chromatic layer dragging the vandalism; - removes only with pressure.	- whitish the chromatic layer - in comparison with MTN94 the cleaning of the embossing its worst; - removes without pressure; - fast action; - chromatic layer sensible to pressure.	- good for thick layers; - affects the chromatic layer dragging the vandalism; - chromatic layer very sensible to the solution.	- doesn't interact with the chromatic layer; -good for thin layers.	- good for thick layers; - when arrives to the chromatic layer starts dissolving then; - optical refraction doesn't change;	- homogenous cleaning; - removes chromatic layer; - uncontrolled; - the first swab was with the vandalic ink, but the other ones where with chromatic layer.

Table 12. Solubility tests on vandalized specimens with Montana Water Base.

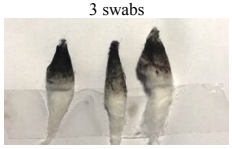
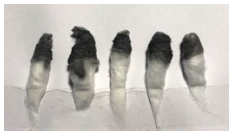
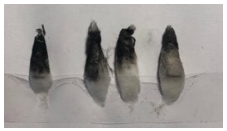
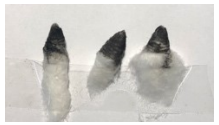
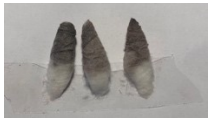
1	2	3	4	5	6	7	8
Swab rolling test (beginning of solubilization)							
61 s.r.t.	34 s.r.t.	78 s.r.t.	2 s.r.t.	3 s.r.t.	57 s.r.t.	2 s.r.t.	28 s.r.t.
Solvent action (min. +; max. +++) | Amount required to remove vandalism paint							
++ 4ml	++ 5,5ml	+ 2ml	+++ 2,5 ml	+++ 1,5 ml	+++ 2ml	+++ 2ml	++ 2ml
Aggressiveness							
++	++	+	+++	+++	+++	+++	+++
Efficiency evaluated on the solvent power and on its management							
+	+	+	++	++	++ thick layer	+++ thick layer	+
Number of swabs to remove vandalism ink							
5 swabs 	4 swabs 	2 swabs 	3 swabs 	3 swabs 	3 swabs 	3 swabs 	2 swabs 
Time needed to remove vandalism ink							
10 min	10 min	4.52min	3.35min	5.17min	5.33min	4.11 min	3.23min
- removes the embossing; - affects the chromatic layer dragging the vandalism; - whitish the chromatic layer;	- removes the embossing; - affects the chromatic layer dragging the vandalism; - removes chromatic layer.	- removes the embossing; - without results.	- removes the embossing; - in comparison with MTN94 chromatic layer resisted more; - removes with normal pressure.	- removes the embossing, but with rolling cleaning doesn't affect chromatic layers.	- removes the embossing; - penetration into the chromatic layer; - sensible.	- good for thick layers; - when arrives to the chromatic layer starts dissolving then.	-removes the embossing; -removes chromatic layer.

Table 13. Solubility tests on vandalized specimens with IVAS SA.

1	2	3	4	5	6	7	8
Swab rolling test (beginning of solubilization)							
100 s.r.t. without results	91 s.r.t.	55 s.r.t.	2 s.r.t.	3 s.r.t.	20 s.r.t.	3 s.r.t.	51 s.r.t.
Solvent action (min. +; max. +++) | Amount required to remove vandalism paint							
++ 3ml	- 3,5ml	+ 2ml	+++ 4 ml	+++ 4 ml	++ 3ml	+++ 2ml	++ 1ml
Aggressiveness							
++	+	+	+++	+++	+++	+++	++
Efficiency evaluated on the solvent power and on its management							
+	+	+	++	+++	++	+++	+
Number of swabs to remove vandalism ink							
4 swabs 	3 swabs 	2 swabs + 1 buffer 	5 swabs 	4 swabs 	4 swabs 	3 swabs 	3 swabs 
Time needed to remove vandalism ink							
10 min	10 min	4.57min + 5min	4.13min	9.30 min	4.34min	4.07 min	5.56min
- removes the embossing easily; - good for thin layers; - uniform cleaning on plain surface.	- without results; - doesn't clean the vandalism; - with pressure doesn't clean either.	- doesn't clean the vandalism; - without results.	- cleaning depends the quantitively of solvent in the swab; - affects the chromatic layer.	- cleaning has to be rolled, not in circles, this way doesn't affect the chromatic layer; - this specimen was irregular morphologic.	- removes the embossing; - penetration the chromatic layer; - whitish the chromatic layer.	- good for thick layers; - when arrives to the chromatic layer starts dissolving then; - cleaning has to be rolled, not in circles, this way doesn't affect the chromatic layer.	-removes the embossing; - homogenous cleaning; -removes chromatic layer; - uncontrolled, penetration the chromatic layer.

ATTACHMENT III

LABORATORY DATA RELATED TO PROTECTING COATINGS ANALYSIS

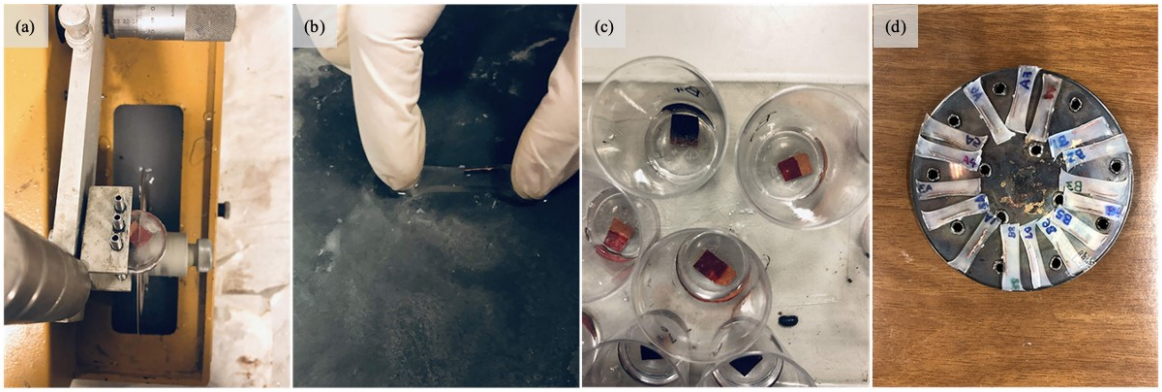
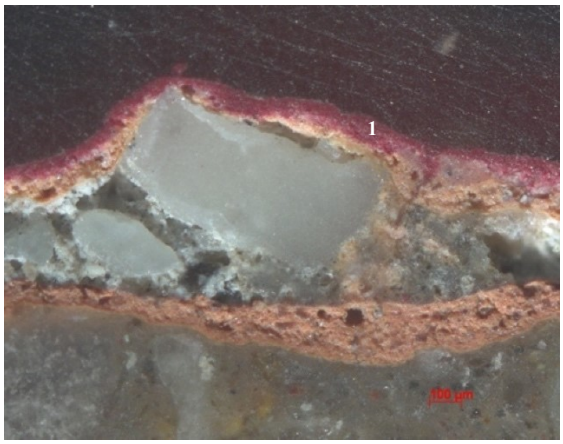


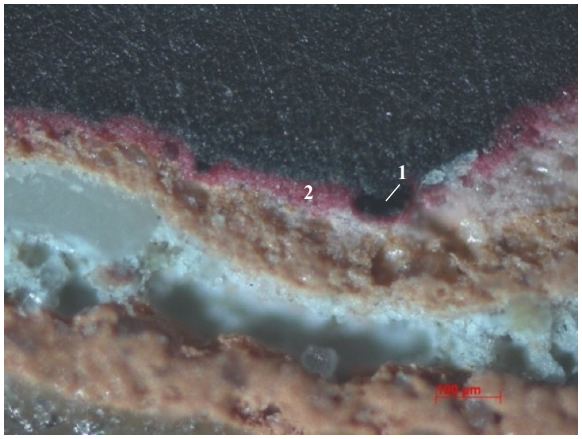
Fig. Att. 12 – Photographic sequence of stratigraphy technique: (a) cross-section; (b) polishing with high grain size sandpaper; (c) embedded samples in an epoxy resin mould; (d) finalized samples for optical microscopy.

Stratigraphic images of specimens A1 to A8 and B1 to B7 (TiO_2 marked samples).



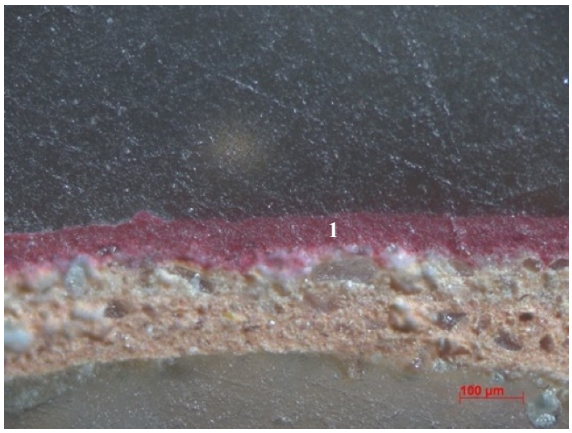
Layer no.	Sample description
1	MTN94 chromatic layer

Fig. Att. 13 – Stratigraphic cut of A1 sample (OM, 5x magnification). IMAR protective coating on MTN94 ink.



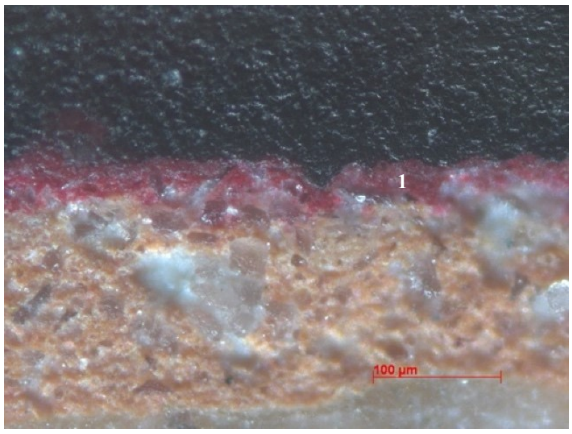
Layer no.	Sample description
1	Black vandalic paint
2	MTN94 chromatic layer

Fig. Att. 14 – Stratigraphic cut of A2 sample (OM, 10x magnification). MTN94 ink with IMAR and black ink vandalism.



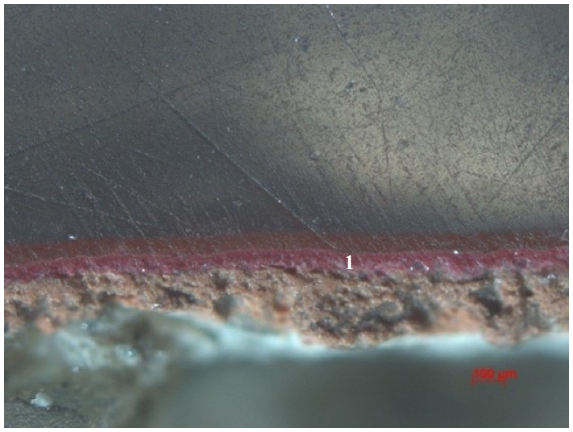
Layer no.	Sample description
1	MTN94 chromatic layer

Fig. Att. 15 - Stratigraphic cut of A3 sample (OM, 10x magnification). Pro-Art protective coating on MTN94 ink.



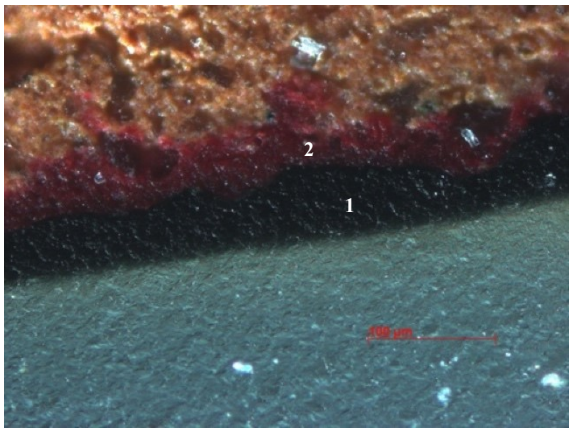
Layer no.	Sample description
1	MTN94 chromatic layer

Fig. Att. 16 – Stratigraphic cut of A4 sample (OM, 20x magnification). MTN94 ink with Pro-Art and black ink vandalism.



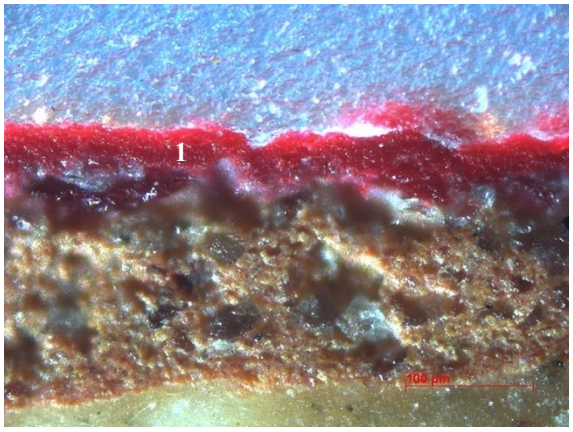
Layer no.	Sample description
1	MTN94 chromatic layer

Fig. Att. 17 – Stratigraphic cut of A5 sample (OM, 10x magnification). IBIX protective coating on MTN94 ink.



Layer no.	Sample description
1	Black vandalic paint
2	MTN94 chromatic layer

Fig. Att. 18 – Stratigraphic cut of A6 sample (OM, 20x magnification). MTN94 ink with IBIX and black ink vandalism.

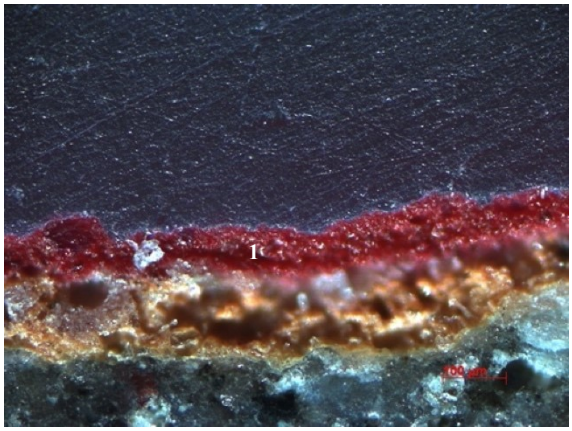


Layer no.	Sample description
1	MTN94 chromatic layer

Fig. Att. 19 – Stratigraphic cut of A7 sample (OM, 20x magnification). KEIM protective coating on MTN94 ink.

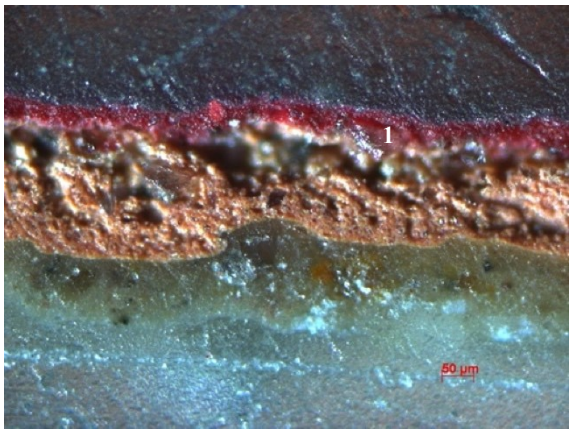
Layer no.	Sample description
1	Black vandalic paint
2	MTN94 chromatic layer

Fig. Att. 20 – Stratigraphic cut of A8 sample (OM, 20x magnification). MTN94 ink with KEIM and black ink vandalism.



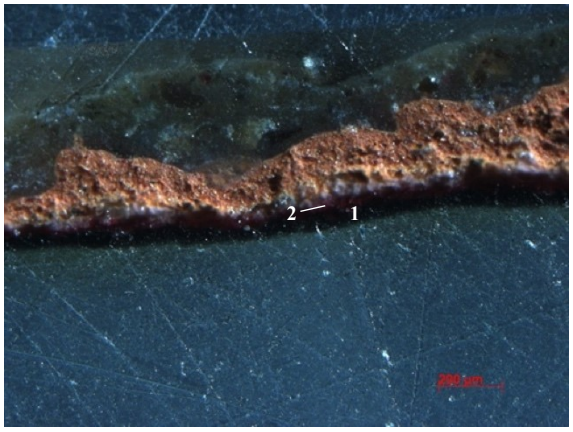
Layer no.	Sample description
1	Ivas SP chromatic layer

Fig. Att. 21 – Stratigraphic cut of B1 sample (OM, 10x magnification). IMAR protective coating on IVAS SP ink.



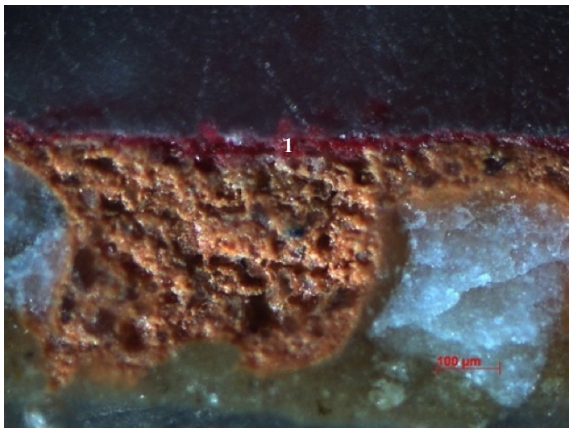
Layer no.	Sample description
1	Ivas SP chromatic layer

Fig. Att. 22 – Stratigraphic cut of B3 sample (OM, 10x magnification). Pro-Art protective coating on IVAS SP ink.



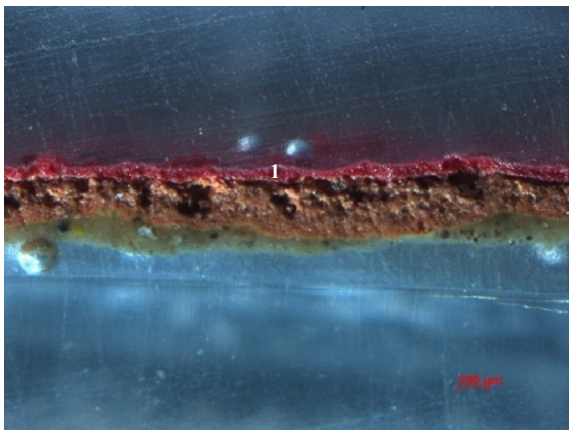
Layer no.	Sample description
1	Black vandalic paint
2	Ivas SP chromatic layer

Fig. Att. 23 – Stratigraphic cut of B4 sample (OM, 5x magnification). IVAS SP ink with Pro-Art and black ink vandalism.



Layer no.	Sample description
1	Ivas SP chromatic layer

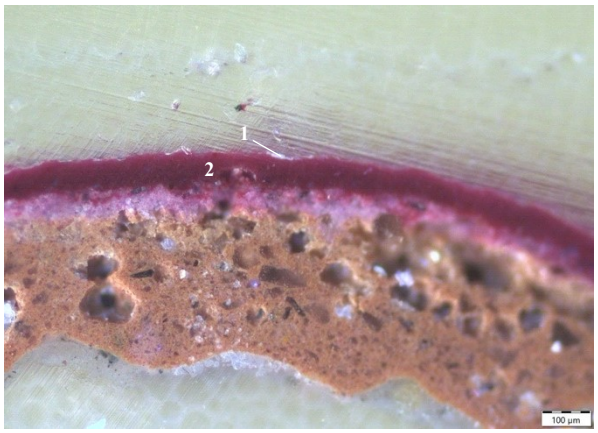
Fig. Att. 24 – Stratigraphic cut of B5 sample (OM, 10x magnification). IBIX protective coating on IVAS SP ink.



Layer no.	Sample description
1	Ivas SP chromatic layer

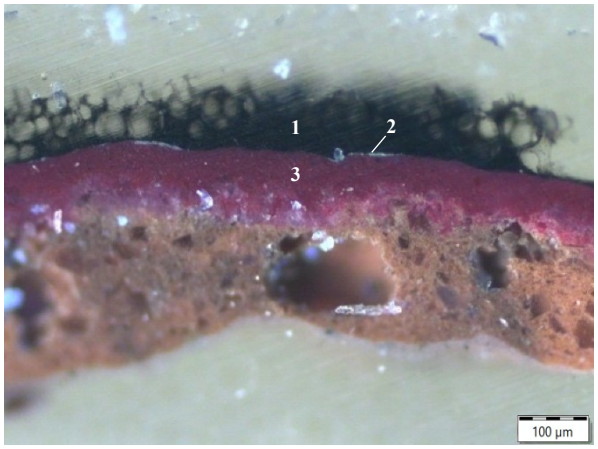
Fig. Att. 25 – Stratigraphic cut of B7 sample (OM, 5x magnification). IBIX protective coating on IVAS SP ink.

Stratigraphic images of specimens A31 to 34 and B31 to B34 (Zn marked samples).



Layer no.	Sample description
1	IMAR protective coating
2	MTN94 chromatic layer

Fig. Att. 26 – Stratigraphic cut of A31 sample (OM, 10x magnification). IMAR protective coating on MTN94 ink.

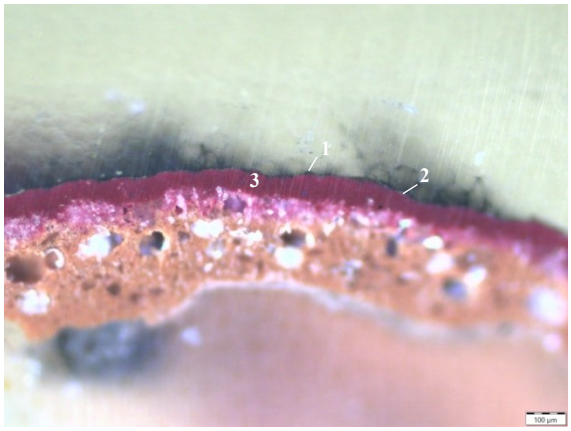


Layer no.	Sample description
1	Black vandalic paint
2	IMAR protective coating
3	MTN94 chromatic layer

Fig. Att. 27 – Stratigraphic cut of A31.1 sample (OM, 10x magnification). MTN94 ink with IMAR and black ink vandalism.

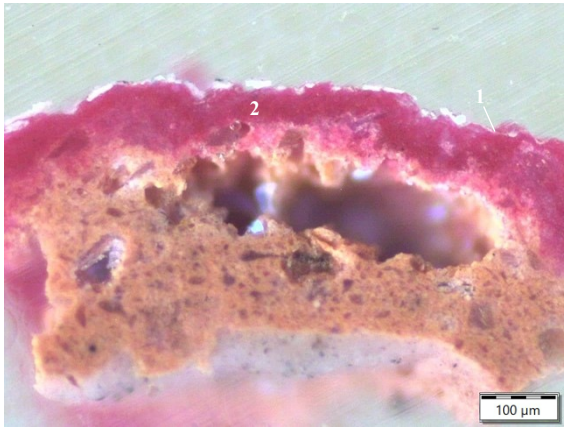
Layer no.	Sample description
1	Pro-Art protective coating
2	MTN94 chromatic layer

Fig. Att. 28 – Stratigraphic cut of A32 sample (OM, 10x magnification). Pro-Art protective coating on MTN94 ink.



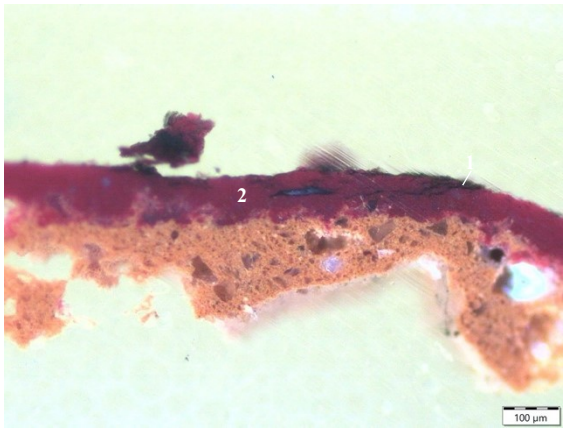
Layer no.	Sample description
1	Black vandalic paint
2	Pro-Art protective coating
3	MTN94 chromatic layer

Fig. Att. 29 – Stratigraphic cut of A32.1 sample (OM, 10x magnification). MTN94 ink with Pro-Art and black ink vandalism.



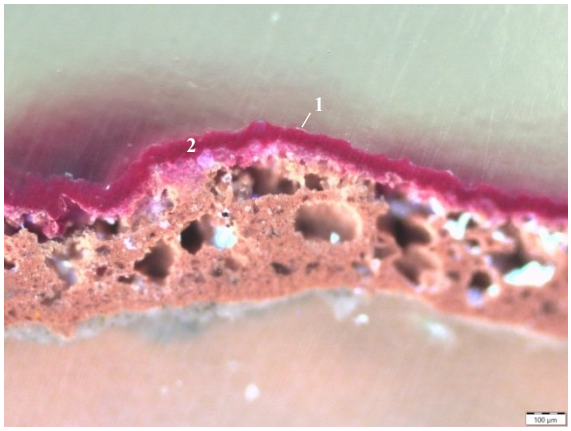
Layer no.	Sample description
1	IBIX protective coating
2	MTN94 chromatic layer

Fig. Att. 30 – Stratigraphic cut of A33 sample (OM, 10x magnification). IBIX protective coating on MTN94 ink.



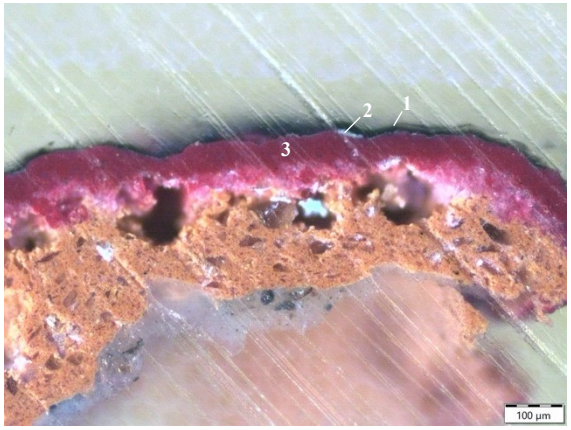
Layer no.	Sample description
1	Black vandalic paint
2	MTN94 chromatic layer

Fig. Att. 31 – Stratigraphic cut of A32.1 sample (OM, 10x magnification). MTN94 ink with IBIX and black ink vandalism.



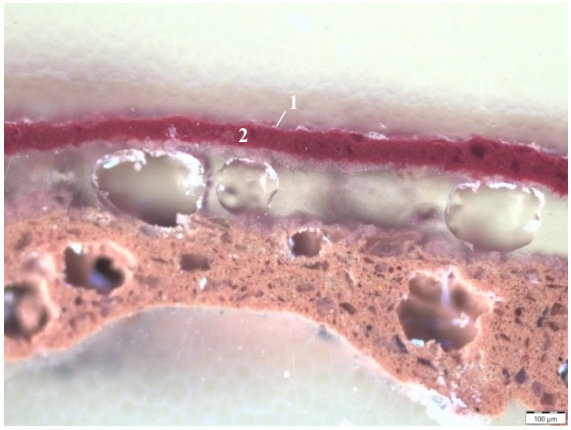
Layer no.	Sample description
1	KEIM protective coating
2	MTN94 chromatic layer

Fig. Att. 32 – Stratigraphic cut of A34 sample (OM, 10x magnification). KEIM protective coating on MTN94 ink.



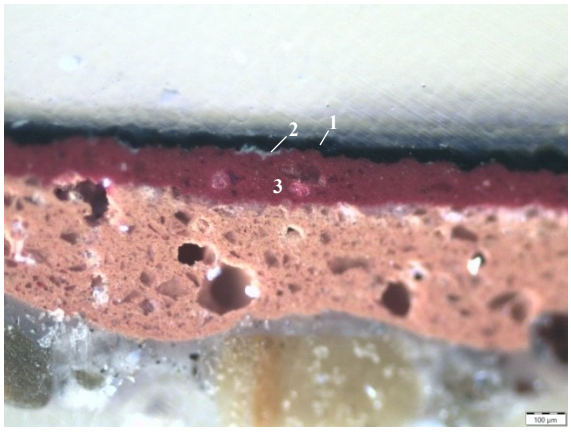
Layer no.	Sample description
1	Black vandalic paint
2	KEIM protective coating
3	MTN94 chromatic layer

Fig. Att. 33 – Stratigraphic cut of A34.1 sample (OM, 10x magnification). MTN94 ink with KEIM and black ink vandalism.



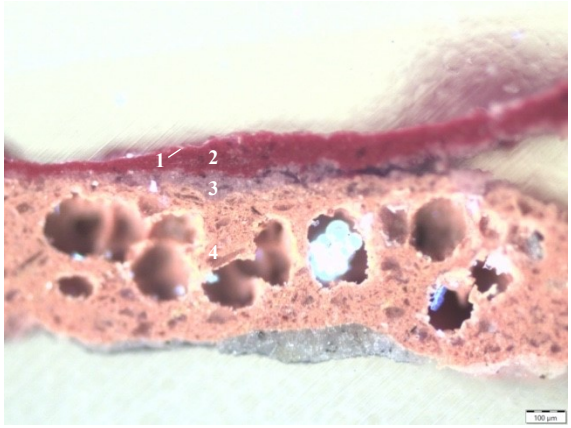
Layer no.	Sample description
1	IMAR protective coating
2	Ivas SP chromatic layer

Fig. Att. 34 – Stratigraphic cut of B31 sample (OM, 10x magnification). IMAR protective coating on IVAS SP ink.



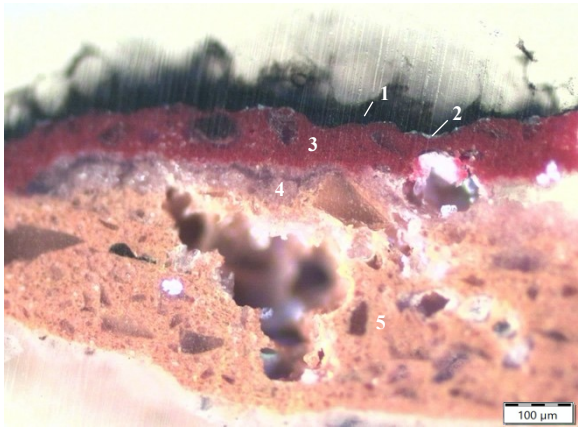
Layer no.	Sample description
1	Black vandalic paint
2	IMAR protective coating
3	Ivas SP chromatic layer

Fig. Att. 35 – Stratigraphic cut of B31.1 sample (OM, 10x magnification). IVAS SP ink with IMAR and black ink vandalism.



Layer no.	Sample description
1	Pro-Art protective coating
2	Ivas SP chromatic layer

Fig. Att. 36 – Stratigraphic cut of B32 sample (OM, 10x magnification). Pro-Art protective coating on IVAS SP ink.

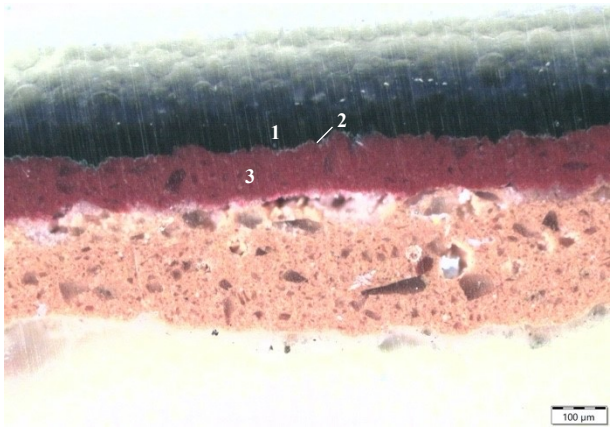


Layer no.	Sample description
1	Black vandalic paint
2	Pro-Art protective coating
3	Ivas SP chromatic layer

Fig. Att. 37 – Stratigraphic cut of B32.1 sample (OM, 10x magnification). IVAS SP ink with Pro-Art and black ink vandalism.

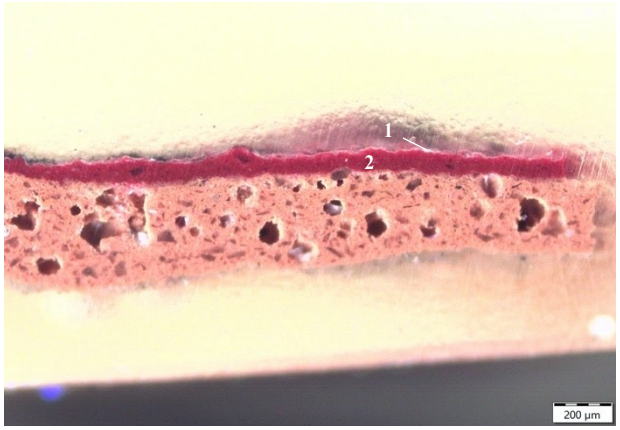
Layer no.	Sample description
1	IBIX protective coating
2	Ivas SP chromatic layer

Fig. Att. 38 – Stratigraphic cut of B33 sample (OM, 10x magnification). IBIX protective coating on IVAS SP ink.



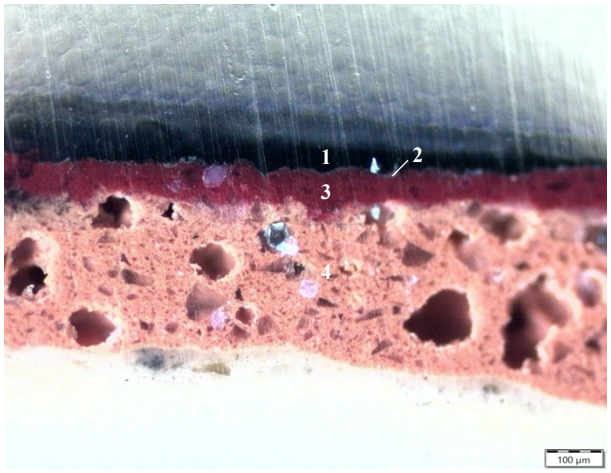
Layer no.	Sample description
1	Black vandalic paint
2	IBIX protective coating
3	Ivas SP chromatic layer

Fig. Att. 39 – Stratigraphic cut of B33.1 sample (OM, 10x magnification). IVAS SP ink with IBIX and black ink vandalism.



Layer no.	Sample description
1	KEIM protective coating
2	Ivas SP chromatic layer

Fig. Att. 40 – Stratigraphic cut of B34 sample (OM, 5x magnification). KEIM protective coating on IVAS SP ink.



Layer no.	Sample description
1	Black vandalic paint
2	KEIM protective coating
3	Ivas SP chromatic layer

Fig. Att. 41 – Stratigraphic cut of B34.1 sample (OM, 10x magnification). IVAS SP ink with KEIM and black ink vandalism.

COLORIMETRIC ANALYSIS

Table 14. Colorimeter data of average of colours in specimens 1 to 20 (at 18.10.19).

Inks	Specimens	L*	a*	b*
MTN 94	A1, A9, A18	33,4625	21,78625	7,34125
Ivas SP	B3, B7, B17	31,25888889	28,60777778	14,00777778
Loop	C1, C10, 17	52,52666667	49,59	21,75
MTN Water Base	D2, D12, D20	33,165	24,44916667	8,681666667
Ivas Idromatt	E2, E9, E19	40,718	36,112	0,164

Table 15. Colorimeter data of colours with one layer of protective coating in specimens 9 to 20 (at 05.03.19).

Inks	Specimens	L*	a*	b*
MTN 94	A9 - IMAR	34,1833333	21,4566667	6,25333333
	A12 - Pro-Art	33,93	21,9833333	6,46
	A15 - IBIX	35,2333333	21,14	6,13
	A18 - KEIM	36,82	20,4666667	5,99666667
Ivas Sp	B9 - IMAR	39,565	21,6925	8,75
	B12 - Pro-Art	33,35	26,9666667	11,78
	B15 - IBIX	36,4833333	23,3733333	9,25666667
	B18 - KEIM	34,58	15,8433333	6,81666667
Loop	C9 - IMAR	60,4975	29,3075	27,2
	C12 - Pro-Art	61,76	27,5675	27,7875
	C15 - IBIX	58,8733333	31,0533333	24,7466667
	C18 - KEIM	60,1266667	31,3333333	23,7
MTN Water Base	C9 - IMAR	35,2233333	26,3333333	10,2866667
	C12 - Pro-Art	34,9825	25,8525	10,28
	C15 - IBIX	35,3733333	26,36	10,5633333
	C18 - KEIM	34,3933333	27,5966667	11,28
Ivas Idromatt	E9 - IMAR	43,0275	38,245	1,5125
	E12 - Pro-Art	44,995	35,3675	2,1125
	E15 - IBIX	44,01	39,945	2,155
	E18 - KEIM	43,555	41,0375	2,09

Table 16. Results of the different measurements made between chromatic layers and after four months and eleven days with one layer of coating.

Inks	Specimens	$\Delta E^*_{ab} = \sqrt{(L^*_2 - L^*_1)^2 + (a^*_2 - a^*_1)^2 + (b^*_2 - b^*_1)^2}$
MTN 94	A9 - IMAR	1,346026924
	A12 - Pro-Art	1,016857728
	A15 - IBIX	2,240673158
	A18 - KEIM	3,84993645
Ivas SP	B9 - IMAR	12,01901725
	B12 - Pro-Art	3,468282727
	B15 - IBIX	8,790181179
	B18 - KEIM	15,02241328
Loop	C9 - IMAR	22,46367045
	C12 - Pro-Art	24,63120697
	C15 - IBIX	19,82090313
	C18 - KEIM	19,87129537
MTN WB	D9 - IMAR	3,2191373
	D12 - Pro-Art	2,79773482
	D15 - IBIX	3,47400192
	D18 - KEIM	4,2622641
Ivas Idromatt	E9 - IMAR	3,4208086
	E12 - Pro-Art	4,75853565
	E15 – IBIX	5,43076735
	E18 - KEIM	6,0015494

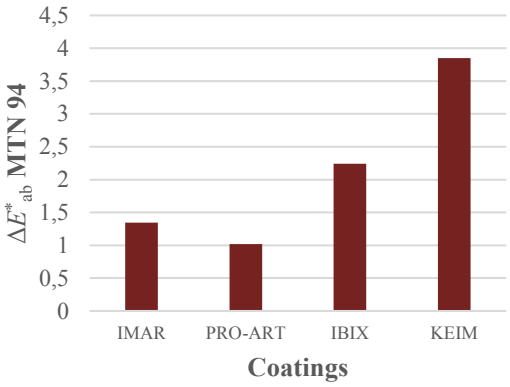


Fig. Att. 42 – Colorimetric measures evaluated between MTN94 ink and four months applied coatings.

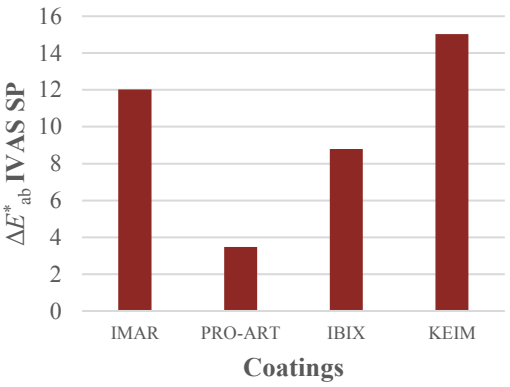


Fig. Att. 43 – Colorimetric measures evaluated between IVAS SP ink and four months applied coatings.

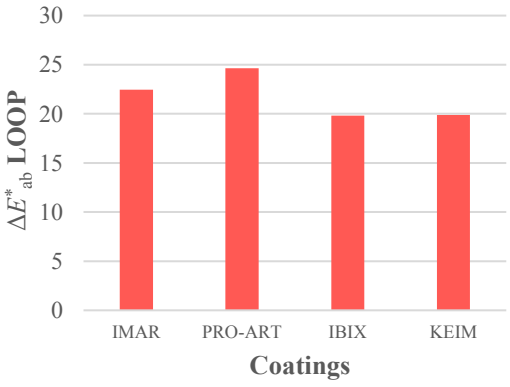


Fig. Att. 44 – Colorimetric measures evaluated between Loop ink and four months applied coatings.

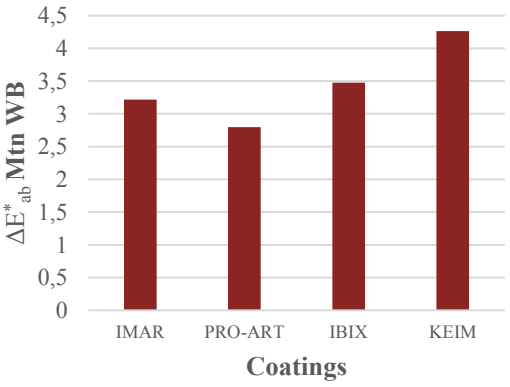


Fig. Att. 45– Colorimetric measures evaluated between MTN WB ink and four months applied coatings.

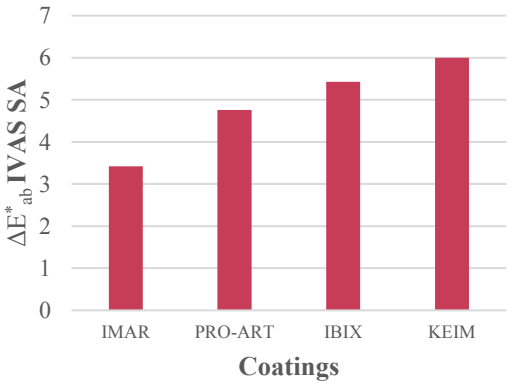
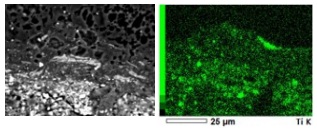
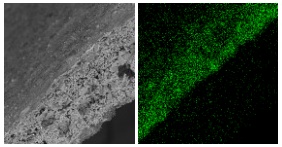
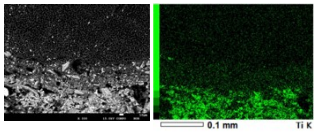
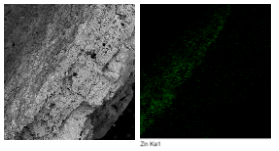
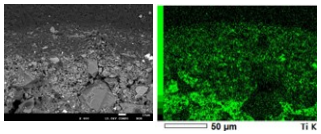
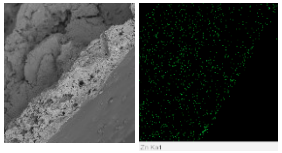
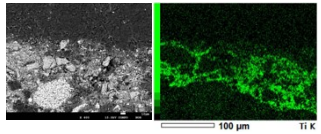
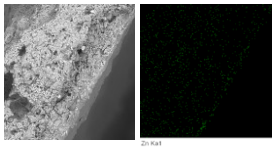
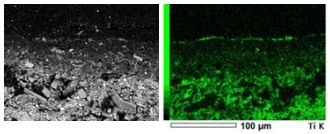
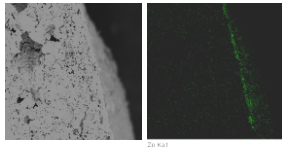
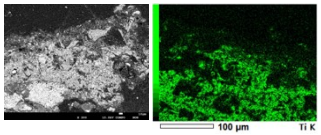
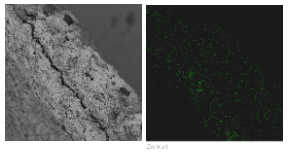
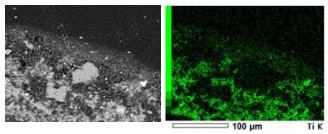
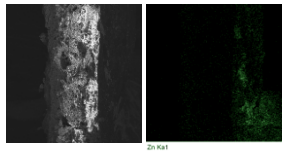
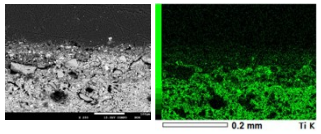
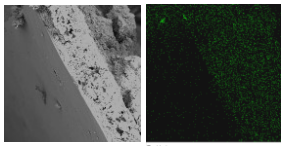
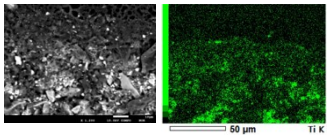
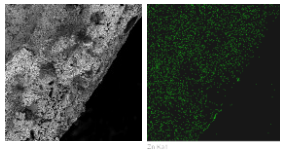
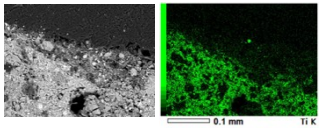
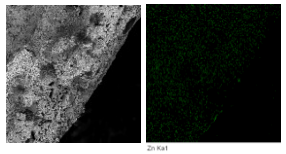
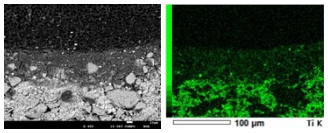
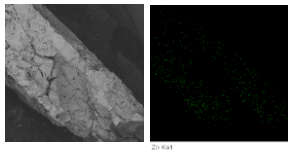
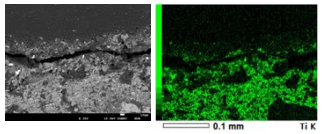
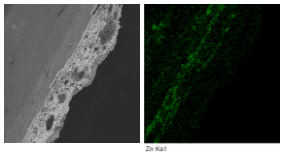


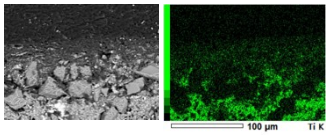
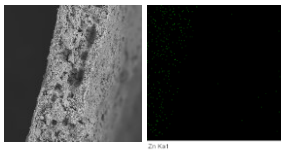
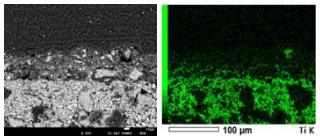
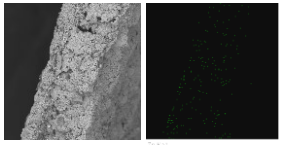
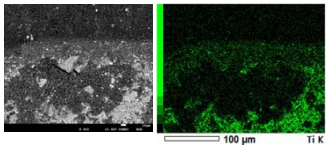
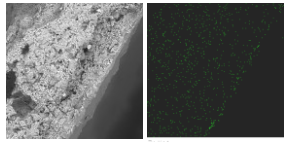
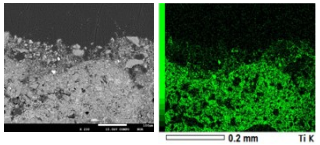
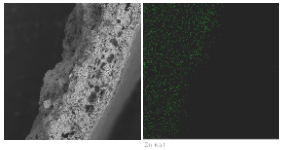
Fig. Att. 46 – Colorimetric measures evaluated between IVAS SA ink and four months applied coatings.

SCANNING ELECTRON MICROSCOPY WITH ENERGY DISPERSIVE SPECTROMETRY (SEM/EDS)

Table 17. SEM/EDS description and image comparison of protecting coatings over the selected inks.

	MTN 94				IVAS SP			
Coatings	**TiO_2**		**Zn**		**TiO_2**		**Zn**	
IMAR	A1	 TiO_2 is present in all layers.	A31a	 Homogenous protective layer.	B1	 No layer. There are no different layers, TiO_2 is present in all layers. It appears to penetrate the chromatic layer.	B31a	 No homogenous but there is a presence of a protective layer.
	A2	 Vandalic ink is mixed with the protective and chromatic layers by the present of TiO_2 in all layers.	A31b	 Presence of Zn in the substrate shows the vandalic ink removed the protective layer mixing with the pictorial layer.	B2	 The vandalic ink is mixed with the protective and chromatic layers by the present of TiO_2 in all layers.	B31b	 Protective layer is mixed with the vandalic ink.

Coatings	MTN 94				IVAS SP			
	TiO_2		Zn		TiO_2		Zn	
Pro- Art	A3		A32a		B3		B32a	
		Protective layer on the surface.		Very homogeneous protective layer.		TiO_2 is present in all layers.		Coating is penetrated inside the chromatic layer.
	A4		A32b		B4		B32b	
		Vandalic ink is mixed with the protective and chromatic layers by the present of TiO_2 in all layers.		Zn appears to have dispersed into the chromatic layer.		Vandalic ink is mixed with the protective and chromatic layers by the present of TiO_2 in all layers.		Zn appears in the vandalized area. Maybe it's an area with few vandalism.
IBIX	A5		A33a		B5		B33a	
		No protective layer. Register clusters of TiO_2 present punctually on the top of the surface, corresponding to the protective coating. Presents TiO_2 throughout the sample.		No protective layer. Zn concentration is homogenous on all the sample.		There are no different layers, TiO_2 is present in all layers. It appears to penetrate the chromatic layer.		No protective layer. The zinc concentration is homogenous on all the sample. The chromatic layer registers a porous surface.
	A6		A33b		B6		B33b	
		Vandalic ink is mixed with the protective and chromatic layers by the present of TiO_2 in all layers		Presence of Zn in the substrate.		No protective layer. TiO_2 is present in all layers. It appears to penetrate the chromatic layer		Vandalic ink is mixed with the protective and chromatic layers by the present of TiO_2 in all layers.

	MTN 94				IVAS SP			
Coatings	**TiO_2**		**Zn**		**TiO_2**		**Zn**	
KEIM	A7		A34a		B7		B34a	
		No protective layer. TiO_2 concentration is homogenous on all the sample.		No data.		No protective layer. There are no different layers, TiO2 is present in all layers. It appears to penetrate the chromatic layer.		The protective layer is penetrated in the pictorial layer. The concentration in surface is very small.
	A8		A34b		B8		B34b	
		No protective layer. TiO_2 concentration is homogenous all over the sample.		Low concentration of Zn is homogenous for all the sample. The vandalic ink and the pictorial layer are mix.		There are no different layers, TiO2 is present in all layers. It appears to penetrate the chromatic layer.		Low concentration of Zn, is homogenous for all the sample. The vandalic ink and the pictorial layer are mix.

ATTACHMENT IV

"VIRTUS" BY HAZUL | DOCUMENTATION, LABORATORY ANALYSIS AND CONSERVATION

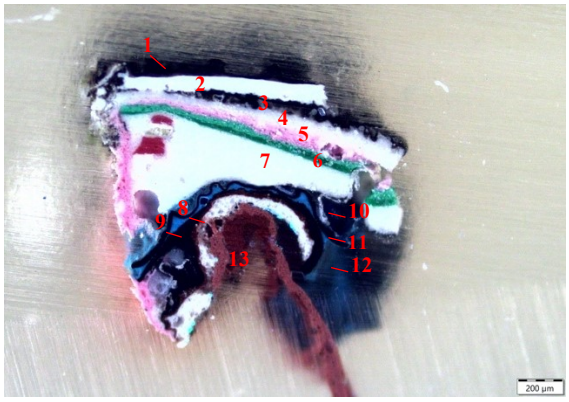
PHOTOGRAPHIC DOCUMENTATION

Fig. Att. 47 – Hazul artwork before intervention.

Fig. Att. 48 – Location of Hazul artwork in Passeio das Virtudes (ext. Google Earth).

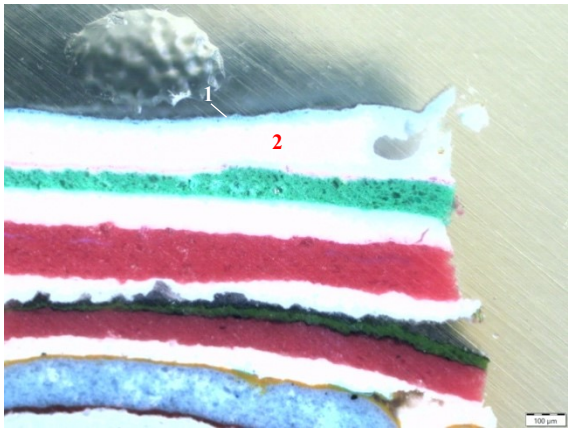
METHODOLOGY AND CONDITIONS OF ANALYSIS

Optical Microscopy observation of stratigraphic sections



Layer no.	Sample description	Thickness (mm)
1	Black vandalic paint	0,09
2	White preparation layer	0,07
3, 4, 5, 6, 7, 8, 9, 10, 11, 12	Old graffiti layers	-
13	Original building chromatic layer	-

Fig. Att. 49 – Stratigraphic cut of C1 sample (OM, 5x magnification). Vandalism layer.

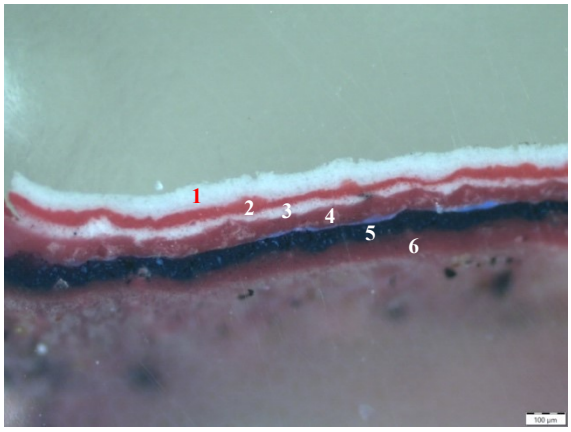


Layer no.	Sample description	Thickness (mm)
1	Blue layer	0,02
2	White preparation layer	0,12

Fig. Att. 50 – Stratigraphic cut of C3 sample (OM, 10x magnification). Blue layer.

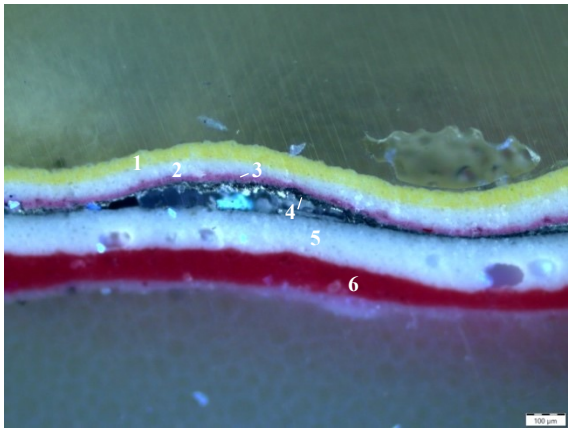
Layer no.	Sample description	Thickness (mm)
1	Blue layer	0,01
2	White preparation layer	0,10
3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13	Old graffiti layers	-
14	Original building chromatic layer	-

Fig. Att. 51 – Stratigraphic cut of C3 sample (OM, 5x magnification). Blue layer.



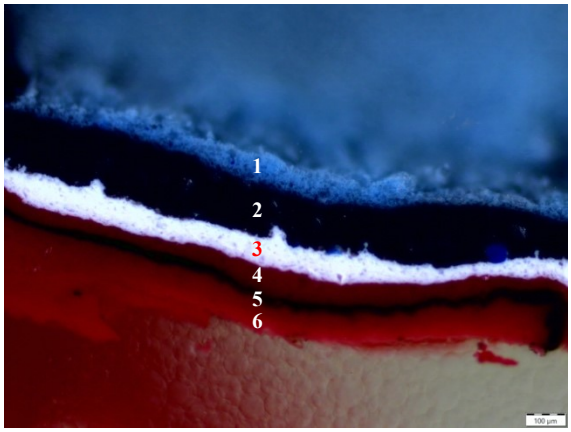
Layer no.	Sample description	Thickness (mm)
1	White preparation layer	0,07
2, 3, 4, 5	Old graffiti layers	-
6	Original building chromatic layer	-

Fig. Att. 52 – Stratigraphic cut of C4 sample (OM, 10x magnification). White preparation layer.



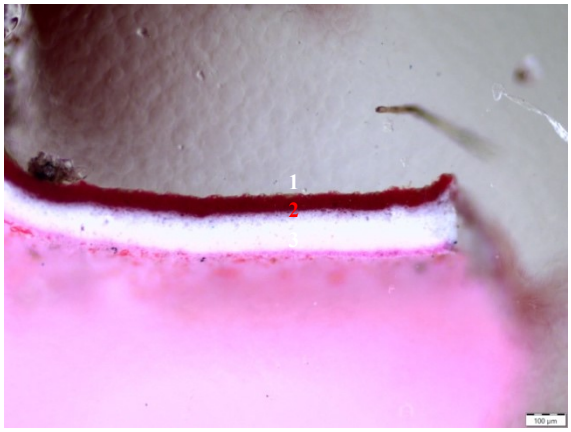
Layer no.	Sample description	Thickness (mm)
1	Yellow layer	0,03
2	White preparation layer	0,04
3, 4, 5, 6	Old graffiti layers	-

Fig. Att. 53 – Stratigraphic cut of C5 sample (OM, 10x magnification). Yellow layer.



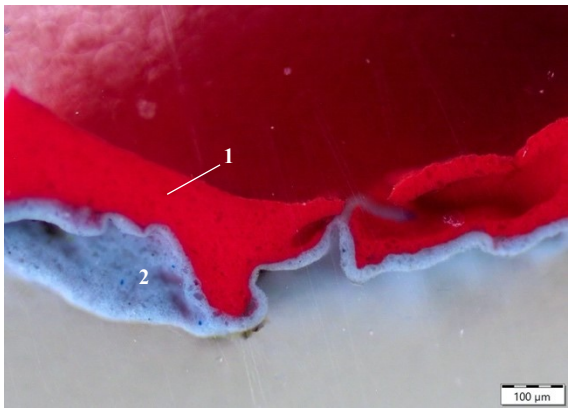
Layer no.	Sample description	Thickness (mm)
1	Grey layer	0,06
2	Black drawing layer	0,13
3	White preparation layer	0,07
4, 5, 6	Old graffiti layers	-

Fig. Att. 54 – Stratigraphic cut of C6 sample (OM, 10x magnification). Grey layer.



Layer no.	Sample description	Thickness (mm)
1	Yellow layer	0,06
2	White preparation layer	0,10
3	Old graffiti layer	-

Fig. Att. 55 – Stratigraphic cut of C7 sample (OM, 10x magnification). Brown layer



Layer no.	Sample description	Thickness (mm)
1	Yellow layer	0,03
2	Old graffiti layers	0,04

Fig. Att. 56 – Stratigraphic cut of C7 sample (OM, 10x magnification). Red layer.

Fourier Transform Infrared Spectroscopy

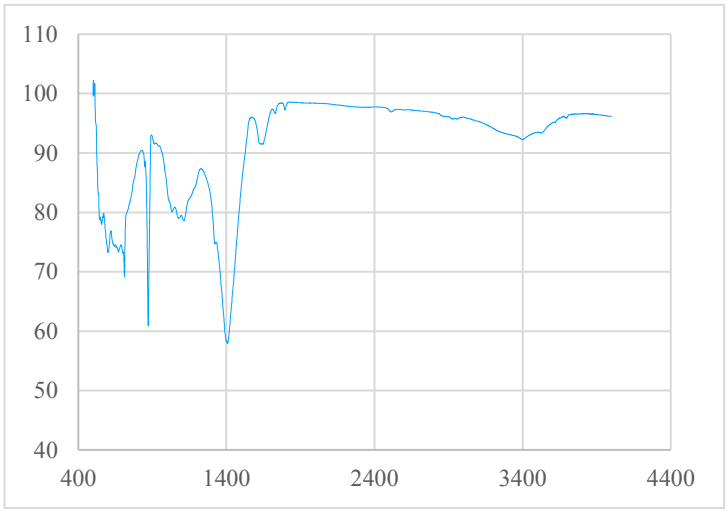


Fig. Att. 57 – Spectrum of IV sample C1, corresponding to calcite in the black vandalism layer. Probably part of the white preparation layer.

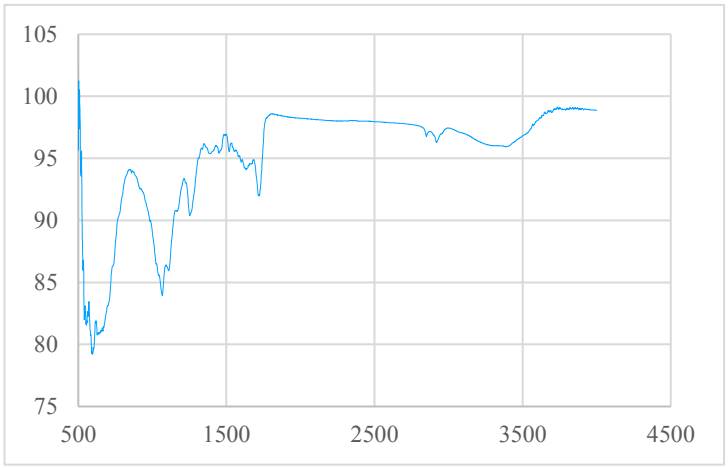


Fig. Att. 58 – Spectrum of IV sample C1, corresponding to alkyd resin in the black vandalism layer.

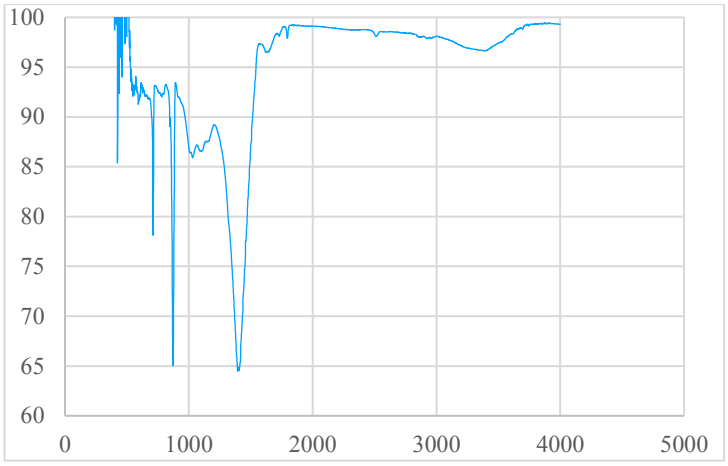


Fig. Att. 59 – Spectrum of IV sample C4, corresponding to calcite in the white preparation layer.

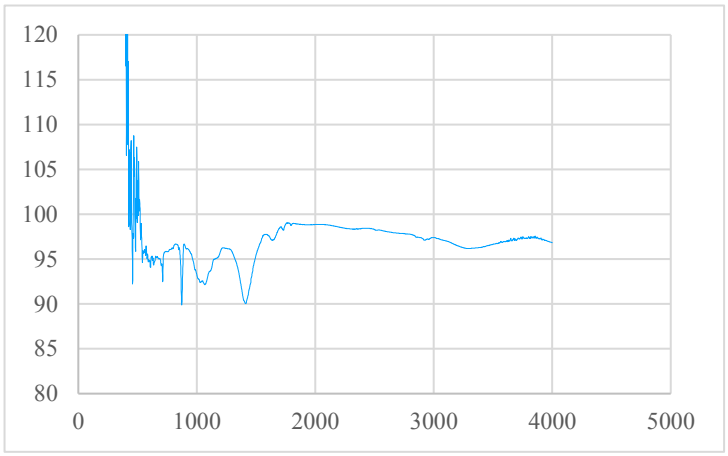


Fig. Att. 60 – Spectrum of IV sample C5, corresponding to calcite in the yellow chromatic layer. Probably part of the white preparation layer.

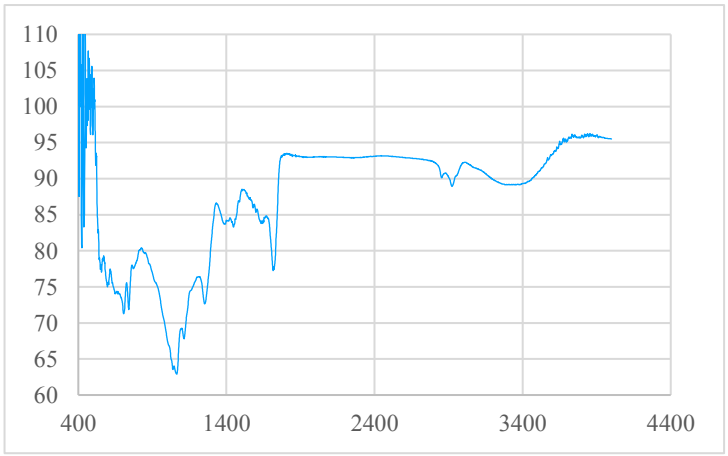


Fig. Att. 61 – Spectrum of IV sample C5, corresponding to alkyd resin the yellow chromatic layer.

STATE OF CONSERVATION

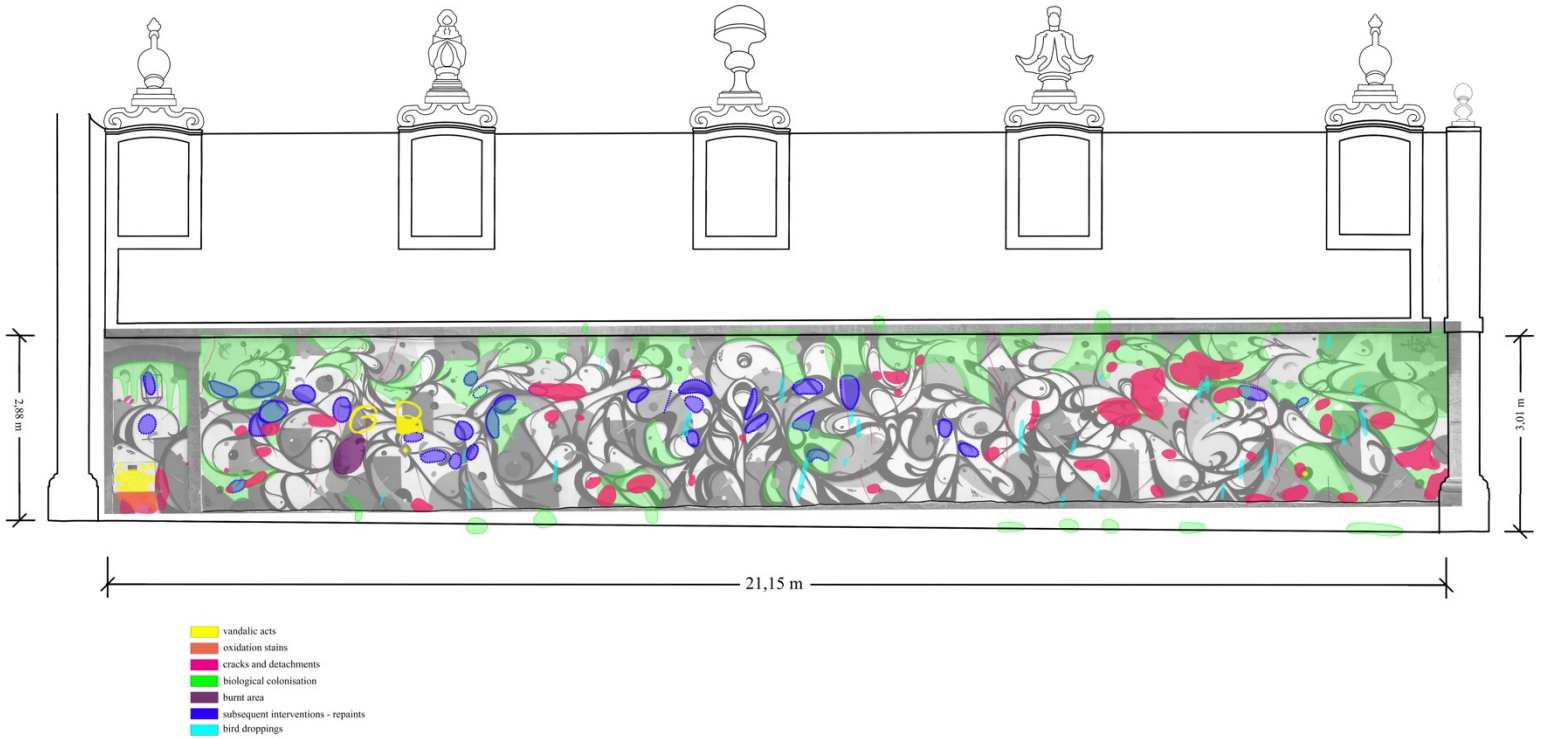


Fig. Att. 62 – Mapping of pathologies of the work "Virtus".

White preparation layer

Fig. Att. 63 – Detachment detail in the white preparation layer.

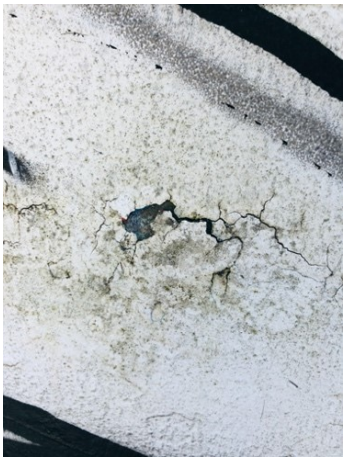


Fig. Att. 64 – Detachment detail in the white preparation layer.

Fig. Att. 65 – Gap detail with active biological colonization in the white preparation layer.

Fig. Att. 66 – Detail of active biological colonization of lichens.

Fig. Att. 67 – Detail of biological colonization of microalgae and surface dirt.

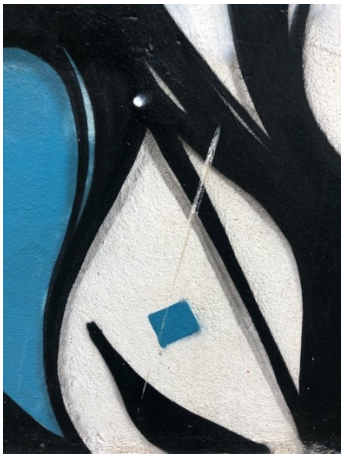


Fig. Att. 68 – Detail of bird excretions on the chromatic layers.

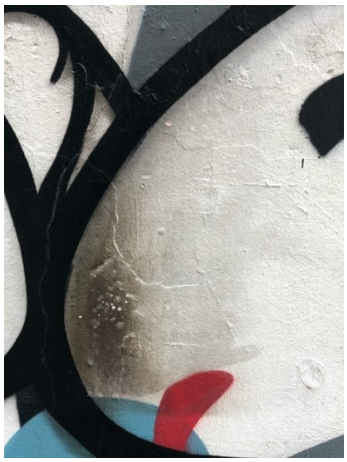


Fig. Att. 69 – Burnt area over the chromatic layers.

Fig. Att. 70 – Detail of the oxidation run-off on the chromatic layer.

Fig. Att. 71 – Detail of vandalism with black aerosol paint over the various chromatic layers.

Chromatic layers

Fig. Att. 72 – Detail of detachment in the blue chromatic layer.

Fig. Att. 73 – Detail of vandalism with black aerosol paint over the various chromatic layers.

Fig. Att. 74 – Detail of detachment and vandalism with sticker in the chromatic layers.

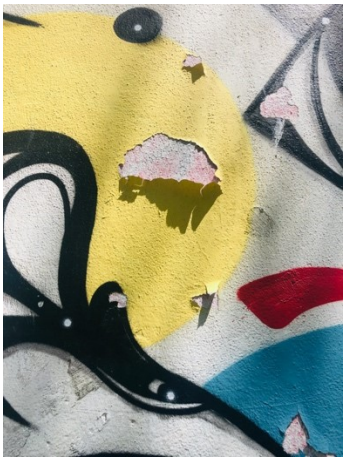


Fig. Att. 75 – Detachments in the various chromatic layers and sticker vandalism in the chromatic layers.

Fig. Att. 76 – Detail of detachment in an area with a repaint in the grey chromatic layer.

Fig. Att. 77 – Detail of bird excretions on the chromatic layers.

Posterior Interventions

Fig. Att. 78 – Detail of fissure and repaint on the white preparation layer.

Fig. Att. 79 – Detail of repaint on the white preparation layer.

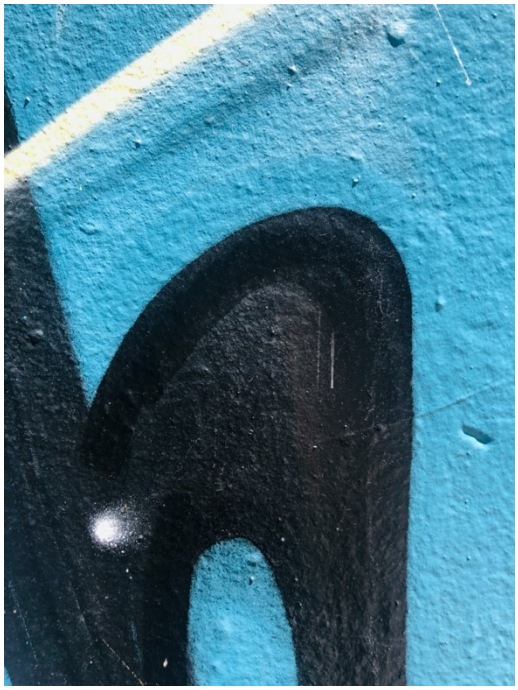


Fig. Att. 80 – Detail of repaint on the black chromatic layer.

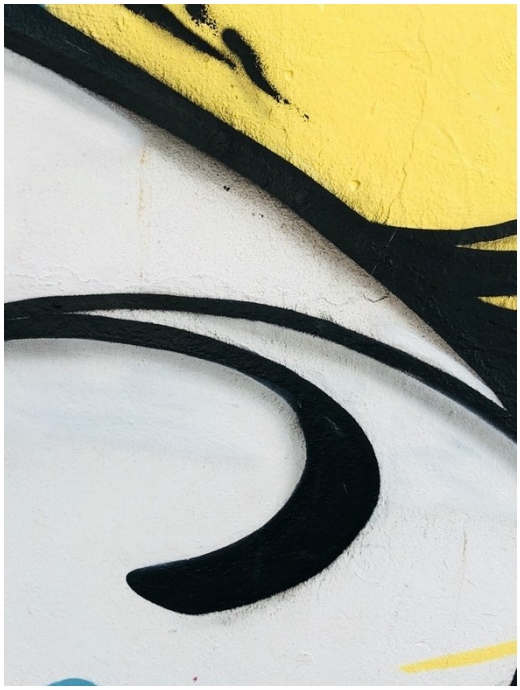


Fig. Att. 81 – Detail of repaint on black chromatic layer with transparency of ancient vandalism.

Fixing the chromatic layer detachments

Fig. Att. 82 – Detachments in the lower right area of the work: a) before intervention; b) adhesion with Plextol B500 scattered at 15% in distilled water.

Fig. Att. 83 – Detachments in the upper right area of the work: a) before the intervention; b) adhesion with Plextol B500 with the original formula.

SURFACE CLEANING OF THE CHROMATIC LAYERS

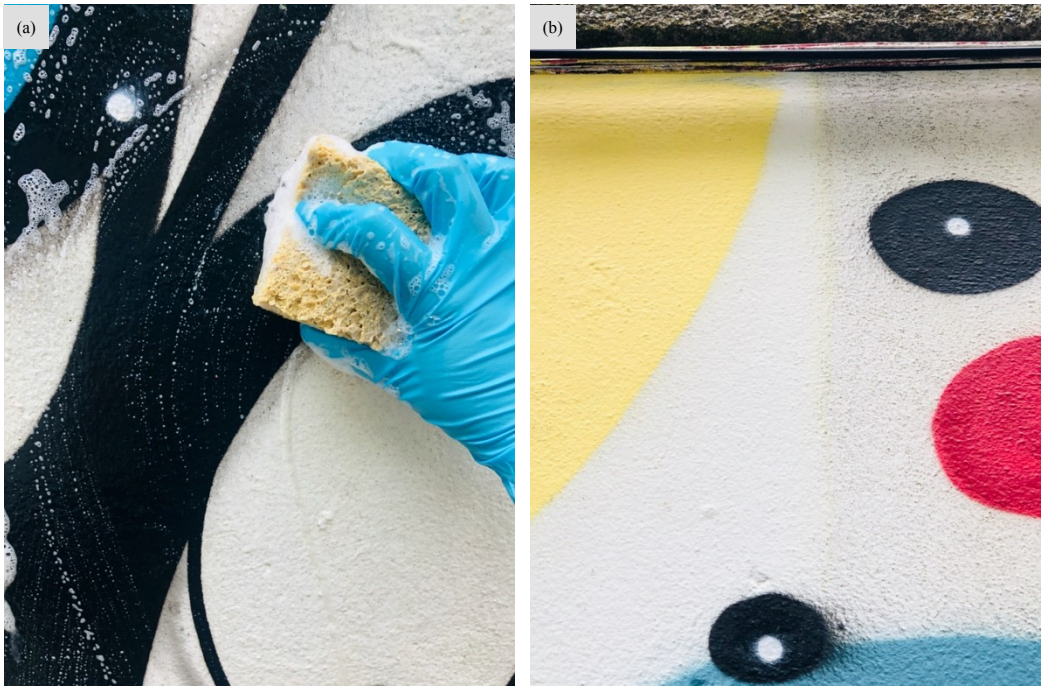


Fig. Att. 84 – Surface cleaning with neutral detergent: a) surface cleaning action with semi-rigid sponge; b) before and after surface cleaning with neutral detergent.

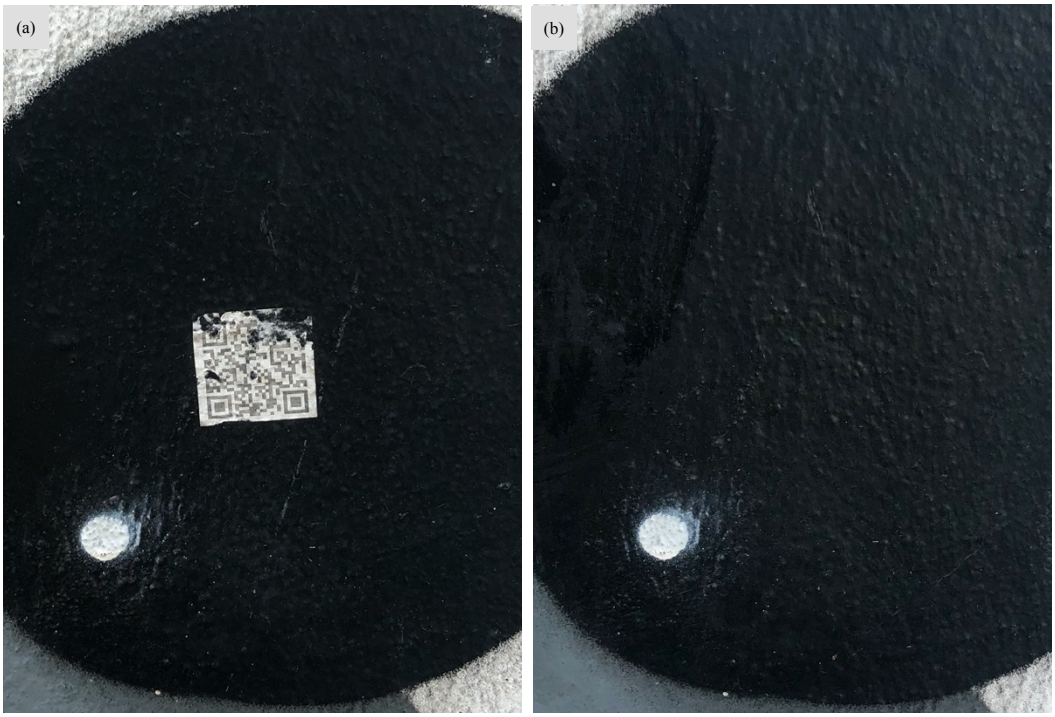


Fig. Att. 85 – Detail of sticker removal with neutral detergent: a) before the intervention; b) after the intervention.

Chemical surface cleaning

Fig. Att. 86 – Chemical cleaning in blue colour.

Fig. Att. 87 – Chemical cleaning in grey colour.

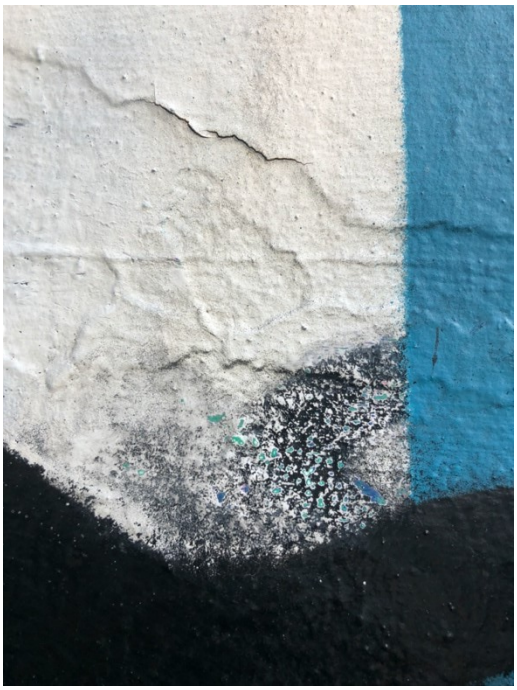


Fig. Att. 88 – Chemical cleaning in a degraded white area.

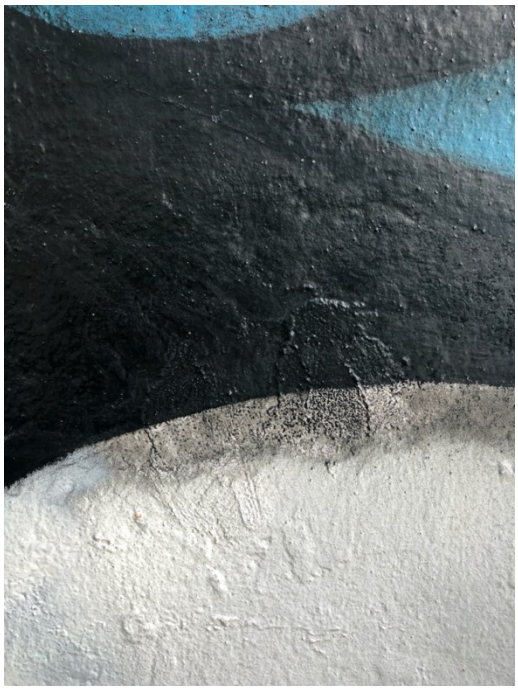


Fig. Att. 89 – Chemical cleaning in a sensitive grey area.

Fig. Att. 90 – Chemical cleaning in chemical cleaning of the orange marker on the water meter compartment cover.

Fig. Att. 91 – Chemical cleaning on the water meter compartment cover, end zones with orange paint impregnation on the chromatic layer.

Fig. Att. 92 – Chemical cleaning with ethyl alcohol in the burnt area.

Fig. Att. 93 – Burnt area after cleaning with ethyl alcohol.

Oxidation removal and biocidal application

Fig. Att. 94 – Removal of oxidation residues with EDTA in cellulose pulp.

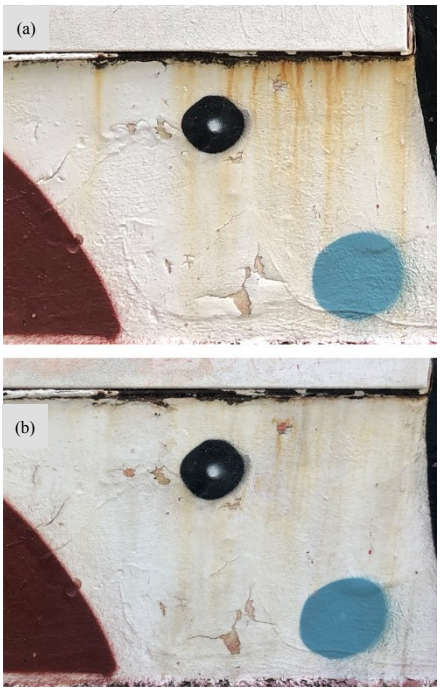


Fig. Att. 95 – Removal of oxidation residues: a) before intervention; b) after intervention.

Fig. Att. 96 – Application of biocide: a) intervention with ethyl alcohol with soft bristle brush; b) detail of solvent evaporation.

Protective coating application

Fig. Att. 97 – Wetting detail in the application of the Pro-Art protective coating.

Fig. Att. 98 – Wetting detail in the application of the protective coating Pro-Art.

Overview of the work after the intervention

Fig. Att. 99 – Overview of the artwork after the intervention.

APPENDIX I

PRODUCTS DATA SHEETS

Fig. Appx. 1 – I.M.A.R Product Data Sheet.

I.M.A.R. ITALIA SRL

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P.I 06376641004

ANTIGRAFFITI I.M.A.R.

SCHEDA TECNICA

Pietre naturali di qualsiasi natura e manufatti edili assorbenti anche di interesse storico artistico e/o monumentale.

Sistema antigraffiti ed antismog a base di cere e fluoropolimeri in emulsione acquosa. Impedisce la penetrazione di vernici, graffiti, pennarelli, spray e l'attecchimento di manifesti ed agevola la successiva pulitura semplicemente con acqua calda in pressione (80/90°C-20/40 bar) utilizzando una vaporella o una idropulitrice . Dona ai materiali trattati idro ed oleo repellenza. La sua totale reversibilità all'acqua calda fa si che il protettivo debba essere riapplicato dopo ogni procedura di eliminazione dei graffiti. Il trattamento non occlude completamente la porosità dei materiali e non ne altera significativamente l'aspetto cromatico; possiede inoltre elevata resistenza ai raggi UV ed alle intemperie. Particolari ed estreme condizioni di stress atmosferico possono ridurre la capacità protettiva del prodotto, quindi per mantenere integra la protezione si consiglia di applicare nuovamente ogni 2 anni.

Applicare il prodotto solo su superfici assorbenti, pulite ed asciutte. E' già pronto all'uso e può essere applicato, a seconda delle necessità, servendosi di vaporizzatore a bassa pressione, rullo o pennello morbido in fibre naturali. Applicare il prodotto in almeno due mani successive, bagnato su bagnato. Per superfici ad elevata porosità si consiglia di applicare il prodotto fino a completa saturazione. Applicare comunque in maniera uniforme evitando ristagni superficiali. Attendere l'asciugatura del supporto al fine di valutare l'efficacia del trattamento. Per la successiva eliminazione dei graffiti, utilizzare una vaporella ad acqua calda alla temperatura di almeno 80°C circa, oppure un'idropulitrice ad acqua calda ed in pressione (almeno 80/90°C-20/40 bar). Dopo ogni operazione di pulizia, deve essere riapplicato in quanto viene completamente rimosso dalle operazioni di rimozione dei graffiti. Si consiglia di effettuare dei test preliminari sulla superficie da trattare al fine di evitare possibili effetti indesiderati.

- Aspetto: liquido lattescente
- Peso Specifico: 1 Kg/l
- Ph: 7,5
- Confezioni: taniche in plastica da 1 / 5 / 10 litri

A titolo puramente indicativo 5-7 mq/l di prodotto (trattamento completo).

I.M.A.R. ITALIA SRL

- Prodotto destinato ad uso professionale.
- Temperature d'impiego +5°C/+35°C
- Non applicare in condizioni di pioggia imminente e in condizioni di pieno sole.
- Proteggere accuratamente le superfici alle quali il prodotto non è destinato.
- Equipaggiare gli operatori come previsto dalle vigenti norme di sicurezza.
- Ventilare adeguatamente i locali chiusi durante l'utilizzo del prodotto.

NOTA: le informazioni in questo bollettino sono basate sulle migliori conoscenze ed esperienza di laboratorio e non impegnano la responsabilità di I.M.A.R. ITALIA srl

Fig. Appx. 2 – NBQ PRO Product Data Sheet.

FICHA TÉCNICA

NBQ PROSPRAYPAINT

1. Descripción

NBQ Prospraypaint es un esmalte sintético mate en spray de secado ultrarrápido. Posee una elevada resistencia al exterior y una excelente adherencia sobre gran variedad de sustratos.

- **Propiedades:**
- Baja presión
- Máxima precisión
- Alta cubrición
- Buena retención del color
- Excelente resistencia a la intemperie
- Gran adherencia
- Muy fácil aplicación.
- No contiene plomo ni cromatos
- Emissions dans l'air intérieur * (Décret nº2011-321 du 23 mars 2011) : B

*La información sobre el nivel de emisión de sustancias volátiles dentro del aire interior, presentan un riesgo de toxicidad por inhalación, en una escala de A+ (emisiones muy fiables) a C (fuertes emisiones)

2. Usos recomendados

Adecuado para su uso tanto en interior como en exterior. Recomendado para decorar y proteger todo tipo de superficies de madera, metal, cartón, piedra, cerámica y muchos tipos de plástico. Ideal para la industria, bricolaje, automoción, fontanería...

3. Presentación

Colores: 50 colores

Envases: 520/400ml

4. Características técnicas:

• Naturaleza	Resina alquídica
• Pigmentos	Elevada solidez a la luz
• Disolventes	Acetatos y cetonas
• Propelente	Hidrocarburos, ricos en C3 y C4

• Densidad	0.98 ± 0.02 gr./cc (Según color)
• Viscosidad	16 – 18 seg. (Copa Ford Nr. 4, 20ºC).
• % sólidos en peso	30 ± 4 % (Valor teórico)
• VOC	530 ± 10 gr./l (Según color)
• Brillo a 60º	< 15
• Rendimiento:	520/400ml; 2 m^2 según el soporte
• Tiempos de secado a 20ºC:	Superficial: 30 min. Total: 2 horas. Repintado: 5 min.
• Temperatura de aplicación	De 10 a 35ºC
• Resistencia del pintado al calor	Recomendado hasta 100ºC
• Inflamabilidad	Extremadamente Inflamable
• Presión:	3-4 bars a 20ºC / 6-7 bars a 50ºC
• Limpieza	Disolvente limpieza en spray
• Vida del producto	> 3 años

6. Instrucciones

La superficie a pintar deberá estar limpia, seca y exenta de cualquier tipo de contaminante.

Para conseguir un acabado perfecto tratar la superficie con una imprimación, selladora o capa de anclaje apropiada.

Agitar enérgicamente el aerosol durante 1 minuto después de que suenen las bolas mezcladoras.

Pulverizar a una distancia de 25/30 cm., aplicando capas finas y rápidas, primero en sentido horizontal y luego en sentido vertical. Es recomendable dar dos capas finas y no una de gruesa para conseguir una cubrición uniforme y evitar descuelgues.

Una vez terminada la operación invertir el bote y pulsar hasta que salga sólo gas para limpiar el pulsador.

7. Seguridad

Los envases llevan las correspondientes etiquetas de seguridad, cuyas indicaciones deben ser observadas. Para más información consultar la Ficha de Seguridad.

La información facilitada en esta ficha técnica, es el resultado de nuestras investigaciones en laboratorio y experiencias reales de aplicación. Sin embargo y dado que frecuentemente los productos se utilizan en condiciones que escapan a nuestro control, no podemos garantizar más que el buen resultado del producto siempre y cuando su aplicación y uso sean correctos.

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