

Preliminary approach to protect Street Art from environmental agents and gaseous pollutants

Laura Pagnin^{1,2}, Francesca Caterina Izzo², Sara Goidanich¹, Lucia Toniolo¹

¹ Politecnico of Milan, Department of Chemistry, Materials and Chemical Engineering “Giulio Natta”, Milan, Italy,
laura.pagnin@polimi.it, sara.goidanich@polimi.it, lucia.toniolo@polimi.it

² Ca’ Foscari University of Venice, Department of Environmental Sciences, Informatics and Statistics, Venice, Italy,
fra.izzo@unive.it

Abstract – In recent years, the interest in developing and assessing protective coatings for the safeguard of Street Art has increased. Considering the complex formulations of spray paints used for these artworks, the study of their degradation phenomena when exposed to atmospheric agents (relative humidity, temperature, UV-light, corrosive gases) is still not fully understood. Within the framework of the SuperStar project, we present a state-of-the-art research and a preliminary investigation to select specific protective coatings, to be tested in the laboratory and on real case studies, and assess their stability and compatibility with the substrate.

I. INTRODUCTION

A. Why Protect Street Art?

Street Art, developed in the 20th and 21st centuries as means through which artists could spread their politicized, ethical, and social messages, has recently been recognized as “Public Art” and, therefore, an artistic movement to be handed down to future generations [1]. Although it was initially considered an act of vandalism by the public opinion, nowadays, it is represented both as an artistic manifestation during festivals and institutional projects able to qualify degraded urban areas and as post-graffiti interventions such as spontaneous artistic expressions [2]. This mental and cultural change has given rise to scientific research and experimentation to determine the best strategies for conserving, restoring, and protecting these artworks. As previously mentioned, the first works of Street Art were illegally carried out on both small and large surfaces, so the action of protection was just related to the substrate, generally part of historical or recent built heritage. Therefore, the first studies focused on synthesizing and evaluating anti-graffiti coatings as these treatments represent a barrier to vandalism actions, aiming to block deteriorating interactions between the artistic materials used (spray paints, markers, and other materials) and the underlying surface [3]. Only in recent years, the protection of Street Art has been extended to safeguard graffiti and murals from atmospheric or anthropic degradation processes. The study of new commercial

products and their chemical-physical stability on painting films brought new national and international research projects with the aim of expanding these scientific aspects. Among them, the SuperStar Project (Progetto di Ricerca di rilevante Interesse Nazionale, Bando 2020) aims to define innovative guidelines for the conservation strategy of Street Art and the safeguard of powerful social and cultural messages in the urban context [4].

II. POLYMERIC MATERIALS USED IN STREET ART

From the 1950s, modern and contemporary art had a deep impact on the development of innovative art materials, involving more and more professionals in the fields such as conservation-restoration, art history, and conservation science. Nevertheless, due to their complex formulations and manufacturing evolution, the knowledge of their chemical, physical, and mechanical stability is still an open issue [5]. The range of materials used in Street Art is widely extended and encompasses brush paints, markers, inks, and above all, spray paints (Fig. 1).



Fig. 1. Spray paint application onsite.

According to the literature [6-8], the main polymeric binders used are *acrylic emulsions*, *styrene-acrylic emulsions*, *oil-modified alkyd-based paints*, and *nitrocellulose resins*. These materials have been investigated and studied by various research groups and organizations through morphological, mechanical,

chemical, and physical analyzes in order to understand their state-of-art, their chemical composition, and to support conservators and restorers in evaluating the prevention of the degradation of these materials when exposed to different atmospheric conditions.

III. ENVIRONMENTAL AGENTS AND POLLUTION AFFECTING STREET ART

The interaction between the surface of art materials and the components present in the ambient atmosphere is inevitable, causing the formation of degradation products and, in many cases, the loss of appearance and/or functionality over time. The main environmental agents that can lead to deterioration are temperature (T), relative humidity (RH) fluctuations, solar irradiation (UV-light), particulate matter, and gaseous pollutants. The latest research [9-11] show that gaseous pollutants have a significant impact on the chemical stability of painting materials. Degradation reactions vary depending on the type of gas under consideration, its combination with environmental humidified water, and their interaction with different polymeric materials and the pigments in the mixture. In fact, according to the last results, different relative humidity values have more influence on acrylic paints, than different gases on alkyd paints, and the gas/RH% combination on styrene-acrylic paints. Prevention and restoration actions should reduce the impact of atmospheric agents and, therefore, the morphological and physical/chemical damage. Many studies were already developed for the characterization and prevention of art objects exposed in indoor environments, in which the parameters such as relative humidity, temperature, and pollutant agents can be more easily controlled [12,13]. The situation becomes more critical when artworks, such as sculptures, murals, and painted objects, are exhibited outdoor, and their monitoring and protection become challenging. The situation is even more problematic when particular pigments and dyes showing a rapid degradation under UV-light are present in the paint formulation [14].

IV. STATE-OF-THE-ART ON PROTECTIVE COATINGS IN STREET ART

Recently, the development and evaluation of several protective coatings became a necessity to preserve the integrity of artworks (especially if exposed outdoor) and slow down the degradation processes. In detail, coatings engineered for cultural heritage should have selected features, following accepted restoration standards and providing ideal protective coating properties, such as transparency, reversibility, compatibility with the surface, long-term durability, low-cost maintenance, and non-toxicity [15]. Most of the literature tested protective coatings on metal, glass, and stone heritage, while the applications related to Street Art protection are still limited, and the degradation and stability behaviors not

well known. In fact, nowadays, there are no ad-hoc created and tailored commercial products for the protection of street artworks. Generally, different classes of protective coatings already tested for different applications are used. Protective coatings for Street Art must have suitable chemical-physical characteristics to protect the painted layers and the underlying material. Among them, we can highlight water repellency, solar-light stability, and chemical inertness. Regarding water repellency, *silicon-based* protectives are generally the best performing and the most widely used [16]. They are divided into silanes (simpler monomeric silicon bonded to alkyl and alkoxy groups) and siloxanes (polymeric and/or oligomeric compounds based on repeating Si-O units with alkyl side chain), which can be organically or inorganically modified, giving an excellent crosslinking density, increased mechanical properties, and good hydrophobic surface properties. An emblematic example of commercial product tested for painted layers is the Hydrophase Acqua (Phase Restauro, Italy), used, for instance, to protect Keith Haring's mural "Tuttomondo" in Pisa by the restorer Antonio Rava [17]. Besides, as said before, different *anti-graffiti systems*, able to cover and penetrate through surfaces forming a protective barrier against possible vandalism phenomena [18,19], are present in the market. The two main classes of anti-graffiti can be defined as permanent and sacrificial [20].

In the anti-graffiti permanent class, the most extensively polymeric material used is *fluorinated or partially fluorinated acrylic*, such as PRO-ART, a rather new commercial product developed by YOCOCU APS (YOUTH in CONSERVATION OF CULTURAL HERITAGE APS, Italy) and Pelicoat Spa [21]. Being a new-generation innovative product able to give interesting photochemical stability, water/oil repellency, it remains important to evaluate the chemical behaviour of this polymer in order to extend its stability and applicability on more complex artistic materials.

The second class of anti-graffiti is represented by sacrificial materials, systems able to be removed from the surface during the graffiti cleaning and then be reapplied after the cleaning process. In this section, *wax coatings* represent one of the main products used. They can be of animal or synthetic origin and are well known for their versatility in isolating the surfaces of even large-sized artworks from the surrounding environment through their flexibility, transparency, and suitability. An example of commercial product studied and applied to street artworks is the AG09W (Keim, Germany), a mix of microcrystalline wax commonly used for building heritage. Being an eco-friendly and sustainable alternative product with low VOCs, it has many advantages such as environmental preservation, the health of the operator, and a low impact on mural artwork [22].

V. DEVELOPMENT OF PROTECTION PROCEDURES WITHIN SUPERSTAR PROJECT

The information acquired on protective coatings in recent literature made it possible to obtain preliminary knowledge both on the chemical nature of the protective materials, their interaction with the environment and the underlying materials, and above all, allowed to develop new research projects aimed to extend their application and test their protective properties on newly formulated artistic materials. Within the framework of the SuperStar project, the research units represented by Politecnico of Milan and Ca' Foscari University of Venice will focus on the development of protection procedures for street artworks, with particular attention to the compatibility and durability of protective systems.



Fig. 2. Superstar project - Case of study in Milan: Necesses by SMOE studio (top) and the Or.me project by Orticanoodle (bottom).

With the support of literature data and an ad-hoc created questionnaire to conservators and restorers who in their careers have been involved in street artworks conservation, several coatings will be selected to be tested and evaluated on naturally and artificially aged mock-ups. Particular attention will be paid to the interaction and adhesion between painting layers and the protective coating, and the influence of cement mortar substrate. Aging procedures to simulate the exposure to environmental agents (temperature excursion, UV irradiation, and rain washout) will be set up. The coating materials will be selected based on three fundamental aspects: compatibility with the substrate and the painting material, effectiveness, and durability. Moreover, film properties such as good applicability,

water repellency, protection from UV-light radiation, oil repellency, and good anti-graffiti will be considered. All treatments will also be tested to evaluate their reversibility and/or re-treatability, using non-invasive and micro-invasive techniques. Specifically, analyses will be performed on specimens before and after protective treatment initially to assess their aesthetic compatibility by colorimetry, glossimetry, Fiber Optic Reflectance Spectroscopy (FORS), and Hyperspectral Imaging (HSI). Subsequently, the interaction between the water in the substrate and the paint layer with and without the protective coating will be considered by contact angle measurements and water absorption by capillarity. The adhesion of the layers will be tested by Scanning Electron Microscopy (SEM) and micro-scratch tests. All analyses will also be performed for the comparison of the sample stability before and after artificial aging (UV-light, T/RH, rain) also considering the degradation of the paint layers from a chemical point of view by micro-Fourier Transform Infrared Spectroscopy (μ FTIR and μ ATR). The research will also consider onsite applications and assessment of protective systems in real case studies. The selected street artworks (Fig. 2) are located in Milan and were realized by SMOE studio (2021) and the Or.me project (2017). A first inspection of the artworks and the meetings with the competent authorities have highlighted the administrative problems related to the diagnostic campaign to be carried out in public spaces and the chemical-physical deterioration processes of the painting layers already ongoing. The results will support institutions and entities engaged in safeguarding public urban art to define and implement guidelines for conservation.

VI. CONCLUSIONS

Having been recognized only in the latest years as Cultural Heritage to be protected, Street Art has assumed social, political and ethical value all over the world. In the scientific fields, this means that the characterization of paint materials, their interaction with the outdoor environment, their chemical-physical degradation and finally their durability has become important. With these new perspectives, this project focuses on the development of a preservation strategy for Street Art, combining non-invasive and micro-invasive techniques in order to analyze the chemical-physical properties and deterioration factors of modern painting materials constituting these artworks. The specific objective of the research unit represented by Politecnico of Milan and Ca' Foscari University of Venice will be the development of protection procedures for street artworks. Particular attention will be given to the compatibility and durability of protective systems when materials are located in different urban environmental contexts and subjected to anthropogenic

and climatic stress. In addition, the project brings together the strong collaboration among the various partners in the diagnostic, scientific, and conservation fields to provide results on innovative cleaning procedures for outdoor mural restoration, vandal graffiti removal, and an integrated protocol for sustainable protection and long-term monitoring. The results will support institutions engaged in the preservation of urban public art and the development of conservation guidelines.

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