Nanomaterials to preserve ancient works of art

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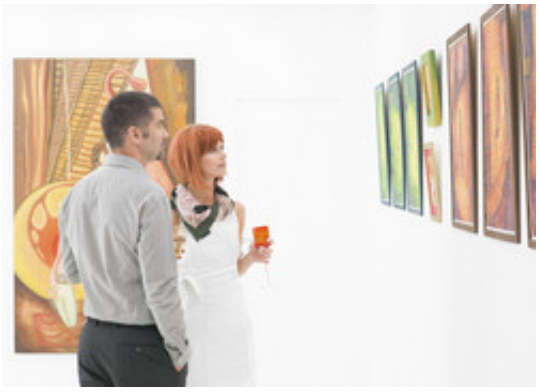

Little would we know about history if it weren't for books and works of art. But as time goes by, conserving this evidence of the past is becoming more and more of a struggle. Could this all change thanks to the NANOFORART project? In an effort to overcome the limitations of traditional restoration techniques, the team has developed promising nanomaterials which are expected to hit the market soon.

For many people, discovering an unknown city or country rarely comes without its share of art museums and exhibitions. Unique work of arts are indeed an integral part of what makes culture and history so fascinating, and their trade weighs quite heavily in today's economies. In 2013, the global art market generated some EUR 47.42 billion,

according to the European Fine Art Foundation.

This all explains why art conservation is becoming more and more of a concern. The most ancient works of art are increasingly suffering the ravages of time, while traditional restoration techniques pose serious problems in terms of physico-chemical compatibility with substances contained in artefacts and toxicity. The materials commonly used for restoration, such as coatings of synthetic polymers or inorganic materials, have a different composition than that of the original artefacts which causes them to alter their main properties.

This is where the NANOFORART (Nano-materials for the conservation and preservation of movable and immovable artworks) project comes in. The three-year project, which ends this month, has developed advanced nanomaterials for preventive conservation of works of art. In this exclusive interview for the research*eu results magazine, Prof. Piero Baglioni sheds light on the main benefits of these new products, the advances made by his team and the expected commercialisation date, and expands on what's to come under Horizon 2020.

What are the main objectives of the project?

The lack of physico-chemical compatibility between restoration materials and artefacts, along with the former's toxicity, were the two main aspects that prompted us to propose the NANOFORART project. At the time, we had been working on the development of effective conservation methodologies since the 1990s, and our activity had already been acknowledged within both scientific and conservation communities.

Our main aim was to improve the methodologies already developed in the lab and partly tested in several conservation workshops across the world, and make them available on a large scale. This involved

nanomaterials that are physico-chemically compatible with the components of works of art, and are either not toxic or have a significantly reduced toxicity level compared to traditional restoration materials like solvents.

What's so innovative about the solutions you propose?

The advanced nanomaterials we have been working on allow for a more precise control of the restoration intervention, for example controlled cleaning can be carried out using microemulsions and chemical hydrogels instead of traditional cleaning methods. The approaches we propose are more reliable than traditional ones, and in some cases allow for a gradual and slower (safer) restoration process.

Overall, the new methods also guarantee stability of the treated artefacts over the long term, as opposed to 'quick' traditional interventions that might have some drawbacks, making later interventions necessary.

How do you explain the lack of advances in conservation techniques?

To give an example, let us consider a wall painting or an easel painting: from a physico-chemical point of view, the painting is typically a layered structure, the surface layers usually being the painted part. Moreover, the materials are usually porous or exhibit a complex composition—they can be classified as composite materials, which means that you need materials science and colloid and surface science to understand and eventually rescue these materials from possible degradation processes.

Properly addressing conservation issues therefore requires a transfer of knowledge from these fields to professionals coming from the humanistic and artistic fields. Such transfer of knowledge is not

straightforward. It requires much dedication and strict cooperation mechanisms between many different interdisciplinary groups and institutions.

Before NANOFORART, such interactions existed but almost exclusively to develop advanced diagnostic techniques for the characterisation of works of art and their degradation processes. While being essential, these diagnostic techniques cannot be considered as an exclusive method for fulfilling this task. We could compare preservation of cultural heritage to medicine, where the works of art play the role of the patients: diagnostic techniques are fundamental to understanding the disease (degradation processes), but must then be complemented by the development of medicines (advanced restoration materials) to cure the patient (restore the work of art).

These are the main reasons that so far have slowed down advances in conservation techniques.

What were the main difficulties you faced in the development of these new materials?

Actually, if one has the right knowledge, there are no major difficulties in the development of new materials. The main difficulty lies in the fact that optimising the developed materials is time consuming and requires very in-depth knowledge of multidisciplinary fields. The number of degradation processes affecting a large variety of works of art requires the development of new methodologies and materials, whose formulation poses significant challenges in terms of human resources.

What do you expect in terms of performance compared to existing technologies?

The new materials we developed are significantly different from traditional methods. They are tailored to the conservation task and take advantage of concepts and solutions provided by advanced materials and colloid sciences, and more generally nanosciences.

These materials are able to resolve degradation issues while respecting the physical chemistry properties of the original artefacts, which is key to the long-term stability of the treated works of art and their availability to future generations.

There are plenty of examples showing how traditional materials can be detrimental to works of art, for instance wall paintings treated with acrylic and vinyl polymers that seriously damage the painting and in many cases have led to the loss of painted surfaces.

What are the most promising materials you developed?

The project has been successful in producing and effectively testing several new materials for the conservation of works of art, four of which hold much promise.

The first is the dispersion of calcium hydroxide nanoparticles in short chain alcohols for the consolidation of wall paintings, plasters and stone. These reinforce the artefacts without altering their physico-chemical properties.

The second is the dispersion of alkaline nanoparticles in either short chain alcohols or water for the pH control of movable works of art such as paper, parchment and leather. These materials are extremely useful for limiting the acidic and oxidative degradation of manuscripts and archival/historical documents.

We also came up with nanostructured cleaning fluids such as oil-in-water microemulsions for the removal of dirt and unwanted coatings on works of art. One of the main advantages in using these fluids is that they exhibit a depressed eco-toxicological impact with respect to traditional solvent blends, while still providing high cleaning effectiveness.

Finally, we developed containers such as chemical gels for the delivery and controlled release of the cleaning fluids on water-sensitive surfaces such as paper, parchment and leather. These gels can be applied without leaving residues on the surface of artefacts, as opposed to traditional 'gel-like' thickeners.

When do you expect this technology to hit the market?

Dispersions of nanoparticles of calcium hydroxide for the consolidation of wall paintings, plasters and stone are already available to conservators worldwide under the trademark Nanorestore.

Nanoparticles for the pH control of movable works of art (e.g. paper, wood, canvas) have been branded under the trademark Nanorestore Paper®; gels and microemulsions for the cleaning of wall and easel paintings have been branded as Nanorestore Gel® and Nanorestore Cleaning®. These technologies will be available soon.

What are the next steps for the project, and do you have any follow-up plans after its end?

We are still faced with a gap in preservation strategies and materials for modern and contemporary works of art such as acrylic paintings, plastic sculptures and composite works that include metal, textiles, polymers, etc. For instance, post-1940 artists used and experimented with materials that are radically different from the ones used in classic art, thus they cannot be preserved using the currently available methodologies. These

artefacts often exhibit extremely fast degradation processes, and there is a risk that some of this heritage will be lost within the next 100 years if effective solutions are not found.

This is the reason why we are proposing a new project within the Horizon 2020 call named NANORESTART (Nanomaterials for the REStorartion of the works of modern ART, to highlight the new start with respect to classic art conservation) that aims to conserve modern/contemporary works of art. In order to address this challenge, we have created a unique partnership that groups research institutions and materials science experts together with high-profile museums, conservation centres and experienced professionals in the field of modern art preservation. Leading industrial partners have also been involved to provide the scalability of the restoration materials we will develop, and the transfer of technology to meet market needs.

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