Performance evaluation of a nanostructured polymer-dispersed photocatalytic coating on Carrara marble

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Thanks to their strong potentiality and multiple applications in different research fields, nanotechnologies play a key-role in technical-scientific progress.
The introduction of nanomaterials in the field of Cultural Heritage represents a new frontier that could lead to the solution of several problems related to the conservation of the monuments. In fact, many products currently used in conservation, such as composite based polymeric materials, were studied and tested in various research areas and then readapted to the need of the Cultural Heritage sector. Therefore, applying them to Cultural Heritage requires extensive analytical research aimed at assessing their potentialities and possible risks.
The aim of the present research was to test a protective treatment such as a nanostructured product containing an acrylic polymer.
The latter was applied on Carrara marble specimens (5x5x1 cm) and then exposed in two outdoor environments, Catania and Palermo, characterized by different environmental conditions and sources of pollution. Precisely, the product chosen was the Fosbuild FBLE 200, composed of a titanium dioxide nano-powder (anatase crystalline phase with an average particle diameter of 20 nm dispersed in an aqueous suspension of an acrylic polymer 4 wt%, TiO_2 0.3 wt%) having photocatalytic properties. Furthermore, this product exhibits disinfecting, antimicrobial, water repellent and self-cleaning characteristics. It was applied by brush and tested in two different quantities, as suggested in a previous study [1]. The specimens were exposed and monitored for a 2-year experimental campaign (from July 2011 to July 2013). The results obtained from the exposure of untreated specimens have already been published in a previous work [2].
Samples were then characterized using a multi-analytical approach. In the pre-exposure phase, analyses were carried out through colorimetric tests (to estimate the chromatic alteration of the stone material after application [3]), according to the norms [4], which made it possible to evaluate the suitability of the applied product. After the exposure period, respectively after the first and second year, the samples were characterized by means of stereomicroscope observations, colorimetric analysis, ion chromatography and infrared spectroscopy.
The research made it possible to evaluate the effectiveness of the formulation applied, in mitigating or counteracting the degradation processes and to obtain useful information regarding the possible formation of alteration products and their causes. Investigations have shown that the protective treatment was effective in terms of self-cleaning power during the first year of exposure. Further tests will be necessary in order to optimize the choice of the product and to verify its effectiveness over time.
This experimentation shows that the effectiveness of nano-structured formulations on stone materials should be tested before application on the surfaces of monuments of historical and artistic interest, in order to avoid incorrect and/or ineffective restoration interventions.

References

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