Smart coatings for stones and mortars protection

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Nowadays the conservation and restoration of cultural heritage are an important issue difficult to be completely solved, especially in the case of historical buildings and monuments, which are seriously affected by environmental conditions and atmospheric pollution. The study of materials constituting the historical buildings, such as mortars or marbles, is of interest not only because the artistic and historical value but also because these materials transmit to us information on the ancient technologies used.
In order to avoid both natural and artificial stone decay, mainly due to the interaction with atmospheric pollutants (both gases such as NOx and SO_2 and particulate matter), nanomaterials (nano-oxides) and tradition hydrophobic resin have been widely studied as protective coatings enable to limit the penetration of fluids into the bulk material (Cappelletti et al. 2015a; La Russa et al., 2012).
Commercially available Si-based resins have been applied as protective agents on both stone materials (Carrara, Botticino, Candoglia marbles and Angera stone) and mortars (an Air hardening calcic Lime Mortar, ALM, and a natural Hydraulic Lime Mortar, HLM). Furthermore, since it is well known that the mix of resins with nanoparticles allows to obtain complete buoyancy and self-cleaning properties, hybrid coatings containing home-made TiO_2 and SiO_2 nanoparticles mixed with the commercial silane polymers were applied to stones and mortars (Cappelletti et al., 2015a; Cappelletti et al. 2015b).
The results concerning the physico-chemical characteristics of the bare stones compared with those of the treated samples will be presented and discussed. In order to evaluate the stability of the applied coatings towards degradation induced by solar radiation and interaction with the atmospheric pollution, accelerated ageing tests under UV irradiation (also exposing the samples in a Q-UV tester cabinet) and exposure tests in a typical polluted urban environment have been carried out. For the samples characterization the following analyses have been performed: contact angle measurements, SEM-EDS (Scanning Electron Microscopy with X-ray microanalysis), IC (Ion Chromatography), colorimetric tests by DRS (Diffuse Reflectance Spectroscopy) followed by CIELab elaboration, porosity measurements, water absorption by capillarity and water vapor permeability.
The effectiveness of the coatings highly depends on the specific material. For example in the case of marbles the best performances against yellowing/deterioration have been obtained using the hybrid coating containing SiO_2 nanoparticles. The latter formulation is in fact more stable when the samples are submitted to hard deterioration conditions with respect to the corresponding hybrid system based on TiO_2, (in particular prolonged UV irradiation).

References

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