Preparation and Characterization of Hydroxide of Alkaline Earth Metals Nanoparticle Dispersions for Cultural Heritage Application

Bujar Dida,[a] Francesco Baldassarre,[c] Dafina Karaj,[a] Albana Hasimi,[b] Angela Atomare,[c] Rosanna Rizzi[c] and Dritan Siliqi[c]

[a]*FIMIF, University Polytechnic of Tirana, Tirana, Albania*

[b]*IGEWE, Polytechnic University of Tirana, Albania*

[b]*IC-CNR, Bari, Italy. bujar.dida@fimif.put.edu.al*

bujar.dida@fimif.edu.al

Nanomaterials have been applied in the construction and maintenance of the world cultural heritage with the aim of improving the consolidation and protection treatments of damaged stone. These nanomaterials include important advantages that could solve many problems found in the traditional interventions. The most commonly used inorganic consolidants are the products based on hydroxide nanoparticles due to their compatibility with a large part of the built and sculptural heritage. In this work, a rapid "bottom-up" procedure of the preparation of alcoholic dispersions of calcium hydroxide and strontium hydroxide has been realized. The particles of calcium hydroxide have an average diameter of 360 nm, PdI (Poly dispersion Index) is equal to 0.188 (mono-disperse) and the colloidal particles show a good kinetic stability (600 nm) with a zeta potential of +37mV. The particles of strontium hydroxide show an average diameter of 180nm, PdI is 0.260 and zeta

potential of +14mV. The first studies concerning the use of the Triton X100 as an additive during preparation of strontium hydroxide, under the same experimental conditions, shown that the average particle size changes little (206nm), while the PdI (0.204) and zeta potential of the colloid increases significantly (+49mV). Both hydroxides shown a fast carbonation into air; due to the particle size obtained for these colloids (180~360nm), they can be used for rapid absorption through capillarity of macro-pores of calcareous materials[1-4]. This procedure, moreover, leads to easily reproducible experimental conditions and makes the procedure itself scalable. The characterization is performed by powder X-Ray diffraction and dynamic light scattering. The kinetic stability of nanoparticle dispersions has been determined by UV-VIS spectrophotometric studies at 600 nm.

The authors acknowledge the financial support from CNR (Italy) – MOES - AKKSHI (Albania) Bilateral Agreement Program.

References

[1] Baglioni, P.; Chelazzi, D.; Giorgi, R. *Nanotechnologies in the Conservation of Cultural Heritage: A Compendium of Materials and Techniques*; Springer Netherlands, **2015**.

[2] Chelazzi, D.; Poggi, G.; Jaidar, Y.; Toccafondi, N.; Giorgi, R.; Baglioni, P. Hydroxide Nanoparticles for Cultural Heritage: Consolidation and Protection of Wall Paintings and Carbonate Materials. *J. Colloid Interface Sci.* **2013**, *392* (1), 42–49. https://doi.org/10.1016/j.jcis.2012.09.069.

[3] Ciliberto, E.; Condorelli, G. G.; La Delfa, S.; Viscuso, E. Nanoparticles of $Sr(OH)_2$: Synthesis in Homogeneous Phase at Low Temperature and Application for Cultural Heritage Artefacts. *Appl. Phys. A* **2008**, *92* (1), 137–141. https://doi.org/10.1007/s00339-008-4464-8.

[4] De Tagle, A.; Larson, J.; Teutonico, J. M.; Weiss, N.; Pardo, E. S.; Price, C.; Hansen, E.; Rodriguez-Navarro, C.; Martin, B.; Matteini, M.; et al. A Review of Selected Inorganic Consolidants and Protective Treatments for Porous Calcareous Materials. *Stud. Conserv.* **2014**, *48* (sup1), 13–25. https://doi.org/10.1179/sic.2003.48.supplement-1.13.