

European project NANO-CATHEDRAL: efficacy assessment of nanomaterials for conservation of natural stones

Lazzeri A.¹, Coltelli M.B.¹, Lezzerini M.*², Raneri S.², Castelvetro V.¹, Bianchi S.¹, Toniolo L.¹, Gherardi F.¹, Poli T.¹, Festa L.³, Vicini I.⁴, Ghaffari E.⁵, Weber J.⁵, Ban M.⁶, Rohatsch A.⁶, Fischer R.⁷ & Drewello R.⁸

¹ Consorzio Interuniversitario Nazionale per la Scienza e Tecnologia dei Materiali, Firenze

² Dipartimento di Scienze della Terra, Università di Pisa

³ Istituto Superiore per la Conservazione ed il Restauro, Roma

⁴ Warrant Group s.r.l., Bologna

⁵ Institute für Kunst und Technologie-Abteilung für Naturwissenschaften in der Konservierung, Universität für angewandte Kunst Wien, Austria

⁶ Forschungsbereich für Ingenieurgeologie, Institut für Geotechnik, Technische Universität Wien, Austria

⁷ Institut für Angewandte Biowissenschaften, Karlsruher Institut für Technologie, Karlsruhe, Germany

⁸ Institut für Archäologie, Denkmalkunde und Kunstgeschichte, Otto-Friedrich-Universität Bamberg, Germany

* Corresponding email: marco.lezzerini@unipi.it

Keywords: NANO-CATHEDRAL, consolidants, protectives, natural stones.

NANO-CATHEDRAL project, started in June 2015, develops new nano-materials, technologies and procedures for the conservation of deteriorated stones in monumental buildings, cathedrals and high value contemporary architecture. Cathedrals, distributed throughout Europe, are representative of the diversity of European cultural heritage (Lazzeri et al., 2016).

Five different cathedrals were selected as they may be considered as representative of both different exposure conditions and different types of stones: Cathedral of Pisa (Italy), Cathedral de Santa María of Vitoria-Gasteiz (Spain) as representative of south European “Mediterranean” climate in coastal and continental regions; Sint-Baafs Cathedral of Ghent (Belgium), Cathedral of St. Peter and Mary in Cologne (Germany) and St. Stephen's Cathedral, in Wien (Austria) as representative of north European climate in coastal and continental regions, respectively; the Oslo Opera House, as an example of a contemporary building coated with white Carrara marble. They also represent different lithotypes such as marble, sandstone, limestone.

During the first phase of the project, stones and their decays have been extensively studied. Based on the specific decay phenomena of the selected lithotypes, different products, namely nano-particles based consolidants and protectives exhibiting photocatalytic, anti-fouling and hydro-repellency properties, have been selected for laboratory testing on lithotypes.

To verify fundamental requirements for stone conservation (*e.g.*, they have to preserve the originality of the stone materials, provide high performance treatments, and provide long-term conservation), artificially decayed lithotype specimens for lab tests are prepared and a systematic testing program has been performed for consolidant and protective treatments (Ban et al., 2016). The results of the tests carried out by the laboratories have been employed to improve the products for the second phase of the project, *i.e.*, the application of consolidants and protectives on-site.

Preliminarily, products have been applied and tested on pilot areas, with the aim to develop homogeneous operational guidelines; moreover, *in situ* tests have been carried out before and after the application of the products to evaluate their efficiency and compatibility. The results will be employed to select the best products to apply on the Cathedrals.

Ban, M., Baragona, A.J., Ghaffari, E., Weber, J., Rohatsch, A. (2016): Artificial ageing techniques on various lithotypes for testing of stone consolidants. *in* "Science and Art: A Future for Stone. Proceedings of the 13th International Congress on the Deterioration and Conservation of Stone, Volume 1", J. Hughes & T. Howind, eds. Paisley, University of the West of Scotland, 253-260.

Lazzeri, A., Coltelli, M.-B., Castelvetro, V., Bianchi, S., Chiantore, O., Lezzerini, M., Niccolai, L., Weber, J., Rohatsch, A., Gherardi, F., Toniolo, L. (2016): European Project “NANO-CATHEDRAL: Nanomaterials for conservation of European architectural heritage developed by research on characteristic lithotypes, *in* "Science and Art: A Future for Stone. Proceedings of the 13th International Congress on the Deterioration and Conservation of Stone, Volume 1", J. Hughes & T. Howind, eds. Paisley, University of the West of Scotland, 847-854.