

Laser ablation on polychrome stone surface: a protocol for risk evaluation

Ana Laborde Marquese^{1*}, Marta Gómez Ubierna², José Vicente Navarro Gascón¹, María Antonia García Rodríguez¹, Pedro Pablo Pérez García¹, Livio Ferrazza³

¹Spanish Institute for Cultural Heritage IPCE, Calle Pintor el Greco, 4 28040 Madrid, Spain

²Cathedral of Santiago Conservation Program, Calle Algalia de Abaixo, 20 15704 Santiago de Compostela, Spain

³Institut Valencià de Conservació i Restauració de Béns Culturals IVC+R, Calle Genaro Lahuerta, 25 46010 Valencia, Spain

*ana.laborde@mecc.es

The Spanish Institute for Cultural Heritage (IPCE) is developing a research project within the framework of the Research in Conservation National Plan, with the aim to optimize a protocol for risk and efficacy evaluation of restoration treatments on polychrome stone sculptures.

While in recent years methodologies for the assessment of chemical cleaning have been proposed, the formulation of standard procedures for verification of physical systems has lagged behind. This project aims to provide a systemized analytical support which contributes to the planning and optimization of the laser cleaning strategies for polychrome stone sculptures, in accordance with the European reference standards.

Part of the work is the analysis of treatments carried out on the polychrome surfaces of the Portal of Glory in the Santiago of Compostela Cathedral with Q-switched lasers and different wavelengths. The variety of materials and conservation status of the pictorial layers allow for a wide casuistry on which the research project and study of the effects of laser on polychrome surfaces is based.

The methodology developed during preliminary tests on the restoration of the Portal has helped to determine the parameters of suitable cleaning in each case, to verify the safety of each test material on the monument and to establish a control process of the restoration both *in situ* and in the laboratory. To this end, a type of physico-chemical analysis was carried out: X-ray fluorescence (XRF) by energy dispersive X-ray microanalysis (EDXMA), optical microscopy, scanning electron microscopy (SEM), energy dispersive microanalysis X-ray (EDX) and infrared spectrometry (FTIR). In addition, the test areas were characterized by means of optical analysis: surface scanning, spectral reflectance, colorimetry and 3D macro photogrammetry.

The analytical study was mainly based on the assessment of the materials released as a result of the laser ablation and on the textural and compositional characterization of the cleaned surface. The eliminated particles were collected by interposing a sheet of glass between the polychrome surface and the laser beam and were later fixed into adhesive discs of carbon drivers for analysis by SEM-EDX.

The density and typology of the particles released, the composition of the surface after cleaning and the micro-textural changes (porosity, fusion processes, roughness, etc.) were evaluated in relation to the original surface in each of the cases analyzed.

The result of the work has been a comprehensive, objective and scientific evaluation of the risk and efficacy of each laser cleaning treatment used to develop a standard act of protocol applicable in other cases.
