

Laser conoscopic holography for the assessment of the effects of traditional and innovative cleaning treatments of silver

Claudia Daffara^{1*}, Nicola Gaburro¹, Giacomo Marchioro¹, Alessandro Romeo¹,
Giulia Basilissi², Andrea Cagnini³, Monica Galeotti³

¹*Department of Computer Science, Università degli Studi di Verona, Strada le Grazie 15 - 37134 Verona, Italy*

²*free-lance conservator*

³*Opificio delle Pietre Dure, V. le F. Strozzi 1, 50122 Firenze, Italy*

*claudia.daffara@univr.it

In the complex procedure for the conservation of a work of art, the effective monitoring of the surface treatment, together with the diagnosis of the state and the characteristics of the degradation, is an important step in order to establish a conservation protocol and, in particular, to define guidelines and hence allow for the conservator to adopt the correct cleaning procedure.

The evaluation of the effects of the cleaning requires that the outermost layer of the artwork be inspected with complementary diagnostic techniques to gain information on both materials and surface morphology.

In this work, following this integrated approach, a custom device based on laser conoscopic holography was jointly used with laboratory microscopy techniques for testing the performance of different mechanical procedures for the cleaning of silver alloy objects.

Tarnishing is the main alteration phenomenon for silver alloy artworks, due to the interaction of silver with sulphur-containing compounds in the environment. Even if this modification does not affect the conservation of the objects, it heavily influences aesthetical features. Thus, one of the most important conservation treatments in this case is the removal of tarnishing.

Many different cleaning techniques are proposed, based on mechanical, electrochemical, chemical and physical methods. The mechanical procedure, based on the use of an abrasive powder suspended in a liquid matrix, is of widespread use due to its simplicity and effectiveness. Here, a dry cleaning process based on the use of erasers is tested and compared with traditional mechanical methods. The proposed procedure is expected to effectively remove tarnishing and produce less morphological alteration of the surface than traditional methods.

Silver alloy mockups were artificially tarnished and cleaned using five different erasers and two traditional mechanical methods (calcium carbonate and sodium hydrogen carbonate suspended in water). The effects of these processes on the surface morphology were studied using optical microscopy and scanning electron microscopy. These techniques were proven effective to detect the single defects locally; however, they cannot provide an objective measure of the average roughness at micrometric scale over the sample.

To this aim, the surface structure was investigated with multiscale profilometry, using scanning conoscopic holography and atomic-force microscopy, in order to inspect the alteration of morphology from microscopic to nanoscopic scales. 3D surface metrology is carried out using ISO-25178 standards areal parameters.

The multi-technique methodology is described, from the information provided by the single method and the limit of the performance to the multiscale integration. As reflective metal is challenging for optical techniques, the effectiveness of the optical profilometry device, based on conoscopic holography and custom setup, is discussed in term of its effective resolution.

Preliminary results are presented, which indicate that the proposed dry cleaning methods are very efficient in removing tarnishing and that produces mechanical damages less or similar to traditional methods. The optical profilometry results are of particular significance since this technique allows an in-situ use and a real monitoring of actual artwork surfaces.
