CP1

LOOKING INTO HISTORICAL CRACKS ANALYSING REPAIRED SILVER OBJECTS BY ELECTRON MICROSCOPY

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ABSTRACT

The identification of structural alterations of silver alloy objects of cultural interest is essential to assess their state of conservation and define maintenance programmes. Alterations induced by previous repair and cleaning actions strongly affect the conservation condition, influencing the type and extension of conservation procedures. The detailed analysis of ancient repairs is a subject to be investigated.

In this work, we show the potentialities of scanning electron microscopy in the characterisation of structural repairs and their influence on the conservation state of silver objects. The study of distinct silver objects dated to the 16th and 18th centuries allowed us to show, among others, the non-intentional dealloying of copper due to the use of acid solutions in surface cleanings and cracks resulting from incorrect handling. The data collected by microscopic examination contributed to the definition of preservation and maintenance methodologies applied to those silver objects.

Keywords: Silver alloy, Cultural heritage, SEM, Intergranular corrosion, Dealloying

1. INTRODUCTION

Objects made of silver alloys are frequent in museums and private collections. The definition of conservation methodologies for these objects is essential to assure their preservation and minimize the costs involved in their maintenance.

The alteration of silver objects by atmospheric corrosion is a research topic widely addressed in the literature, including the corrosion mechanisms and intervention methodologies (e.g., cleaning methods, protective coatings, etc.) [1-3]. Less attention has been paid to the influence of past restorations procedures on the objects current state of conservation and future conservation actions of these objects.

The conservation of silver objects usually has two main objectives: to render the characteristic luster of silver, recovering the original perception of the object, and to ensure the structural stability of the objects, a condition that may include the repair of structural alterations such as cracks and fractures.

The need to recover the characteristic shine of silver compels to successive cleaning actions that have consequences for the objects surface. Depending on the methods chosen (e.g. mechanical, chemical, or electrochemical) and the number of times they are applied, there may be removal and loss of material that over the years could be representative [4]. This subject has been addressed by several researchers who study the least invasive interventions for the objects [5,6].

Another issue, more rarely addressed, is the structural alterations such as cracks and fractures. These alterations recurrently appear in objects that had a utilitarian (e.g. salvers, ewers, etc.) or religious (e.g. monstrances, chalices, etc.) function. The continuous use and handling, often associated to manufacturing defects (which involve important mechanical deformations during cold work) [7] may lead to the development of cracks and fractures. To overcome these alterations, the objects were submitted to different repairs over the years during the time of use, before integrating museum or private collections. These historical repairs are important to the history of the object and to understand its state of conservation. Moreover, the identification of alterations and repairs carried out over time is of utmost importance since they can strongly influence and constrain the processes of intervention and maintenance of the objects.

2. DESCRIPTION

Naked eye examination is the most widely used method by conservators for identifying structural alterations (e.g cracks and fissures). However, to characterise some of them, other examination techniques should be used to obtain information on different scales and depths. Scanning electron microscopy (SEM) is one of these techniques, with many advantages such as non-invasive (depending in object dimensions), high resolution, extensive depth-of-field, and wide range of magnification. An additional advantage is that elemental microanalysis can also be performed with an energy dispersive spectrometer (EDS) coupled to the SEM equipment.

The present work illustrates how SEM can contribute to the detailed conservation assessment using two examples of silver alloy objects with cultural interest. It is shown how SEM enabled the identification of the alteration of the metallic surface resulting from the use of acids for cleaning an object. The action led to the dissolution of the copper present in the alloy, leaving the metallic surface porous (non-intentional dealloying of copper). Another example demonstrates, in a cracked area, the development of intergranular corrosion contributing to structural fragility of the object, reason that led to a repair with solder.

3. CONCLUSIONS

The influence of previous repairs on the preservation of ancient silver objects is still an issue that requires research. In this work, we approached the advantages of SEM to characterise the main structural alterations that occur in these objects.

Based on the studied objects, we could reveal the fragility of the metallic structure due to cleaning actions involving acid solutions, and the cause for the use of solder for crack repairs. The structural alterations identified in the studied silver objects made it possible to define the extension of the conservation process and handling requirements.

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