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In-situ multi-analytical study of ongoing corrosion processes on bronze artworks exposed outdoors

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ABSTRACT
This paper presents a long-term in-situ campaign to monitor contemporary bronze statuary exposed outdoors. The case study relates to the characterisation of three sculptures belonging to the Gori Art Collection, located in the Fattoria di Celle: 'Cavaliere' and 'Miracolo – Composizione' by Marino Marini and 'Due forme o due ombre n°2' by Luciano Minguzzi. The overall conservation state of the sculptures was investigated by means of a multi-analytical and non-invasive approach, involving different techniques. Three-dimensional photogrammetry was performed to fully document the artworks. The chemical and microstructural features of the corrosion patinas were then characterised through X-ray fluorescence and Raman spectroscopy. In addition, the stability and the protective effectiveness of the corrosion products were assessed by electrochemical impedance spectroscopy. Thanks to the combined use of these specific techniques, the information extracted through the different analyses could be correlated with each other and with the exposure conditions. The different corrosion products were identified as being primarily copper sulphates and phosphates, and they were correlated with the different microclimate conditions related to their location on the statues. The information gathered from the presented multi-analytical approach represents the fundamental knowledge required to develop a tailored conservation project to assure the long-lasting preservation of these artworks.

Section: RESEARCH PAPER

Keywords: In-situ measurements; Raman spectroscopy; electrochemical impedance spectroscopy; atmospheric corrosion

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1. INTRODUCTION

Conservation prevents or slows the deterioration of cultural heritage by controlling the environment and the artwork's structure to maintain it in as unchanged a state as possible. According to the latest definitions, conservation includes preventive conservation, remedial conservation and restoration. All measures and actions in this field should respect the significance and the physical properties of the cultural heritage item. At the 15th Triennial Conference (New Delhi, September 2008) the ICOM-CC (International Council of Museums - Committee for Conservation) defined the term 'preventive conservation' as 'all measures and actions aimed at avoiding and minimizing future deterioration or loss. They are carried out within the context or on the surroundings of an item, but more often a group of items, whatever their age and condition. These measures and actions are indirect – they do not interfere with the materials and structures of the items. They do not modify their appearance.' [1] Indeed, the deterioration and loss of our cultural heritage are inevitable processes. However, it is possible to slow these processes down and to preserve artworks for as long as possible if the right methodologies and preventive conservation projects are implemented.

When dealing with heritage metallic artefacts, particular care has to be taken because of the strong interaction between these objects and their surrounding environment. Many authors [2]-[4] have discussed the strategies and methodologies necessary to