Innovative procedure based on ^{18}O isotopes and Time of Flight – Secondary Ion Mass Spectrometry (ToF-SIMS) analyses for assessing laser interaction mechanisms on copper alloys

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The present work describes experimental research related to the study of laser cleaning processes of typical corrosion present on archaeological copper alloys [1,2]. An innovative procedure, involving ^{18}O isotopes and Time of Flight – Secondary Ion Mass Spectrometry (ToF-SIMS) analyses, was developed to assess the driving mechanisms of laser-surface interactions.

Preliminary studies were carried out on artificially-corroded Cu-based reference samples using a NIR Q-switched Yb:YAG fibre laser operating in the nanosecond pulsed regime. Those tests were performed in a controlled atmosphere of synthetic air enriched with the ^{18}O, a less abundant oxygen isotope naturally present in the atmosphere. The laser cleaning parameters were selected and then, a surface characterisation was extensively performed on laser-treated and non-treated samples [3]. The presence of re-oxidised compounds was detected, and we could discriminate the oxygen originally present in the corrosion layers and the one introduced by the interaction with the laser (generated through reactions with ^{18}O). To assess the interaction, a set of samples treated with different laser conditions were characterised by FESEM-eds and μ-Raman; ToF-SIMS Spectrometry was used to determine the content and distribution of the oxygen isotope through the corrosion layers.

The results show that re-oxidation phenomena can occur and its selectivity depends on the laser conditions. The characterisation

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conducted is discussed and a model of the laser-surface-atmosphere interaction is proposed. Finally, the method has been validated during the cleaning of an archaeological bronze coin [4].

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