VIRTUAL EUROCORR

Removal of copper corrosion products from archaeological copper alloys using a Q-switch Nd:YAG 1064 laser: impact on selected corrosion products

David Edward WATKINSON[1], William SMITH[1], Nicola EMMERSON[1]

[1] Cardiff University, United Kingdom

Corrosion of archaeological copper alloys during terrestrial burial normally produces a corrosion product profile comprised of a mixed layer of either $CuCl/Cu_2O$ or $SnO_2/CuCl/Cu_2O$ for bronzes, which is overlaid by a corrosion product layer that is normally predominantly comprised of $CuCO_3CuOH_2$. If CuCl has been hydrolysed post excavation, Cu_2OH_3Cl polymorphs may also be present. Aesthetically it is important to expose the shape of an object and to either retain or expose the colour and texture of patinas. Mechanical removal (cleaning) of the outer layers to reveal shape and enhance aesthetics can be labour intensive, while chemical methods are difficult or impossible to control. Laser generated energy potentially offers a controlled method for achieving ethical and aesthetic goals but it's ability to remove or transform commonly encountered copper corrosion products is unknown. The energy a laser produces and its delivery to surfaces is governed by a wide range of variables. Their individual and collective impact on copper corrosion products must be known for laser treatment of archaeological copper alloys to employ evidence-based operating parameters, which deliver predictive outcomes.

This project examined the impact of a Q-switched Nd:YAG 1064nm laser on selected individual corrosion products and their mixtures, which typically occur in corrosion profiles found on archaeological copper alloys. The analogues comprised: $CuCO_3CuOH_2$; CuCl; Cu_2O; 50/50 $CuCl/CuCO_3CuOH_2$mix; and metallic copper. Results made it possible to predict the likely impact of laser ablation on patinas found on archaeological copper alloys. During the experiment only the amount of fluence (energy dispersed over cm^2) was controlled, as the same fluence can be replicated when using other lasers, by adjusting energy and spot size. Analysis of the experimental outcomes employed Raman and FTIR spectroscopy to detect transformations of copper compounds and colourimetry to assess colour changes. This data offers insight into both physical and aesthetic changes that could occur from the use of lasers on archaeological objects.