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OPTICALLY DETECTED X-RAY ABSORPTION SPECTROSCOPY – A TECHNIQUE FOR MONITORING HERITAGE METAL SURFACES

Mark Dowsett[1], Annemie Adriaens[2], Gareth K. C. Jones[1], N. Poolton[3]
[1]Department of Physics, University of Warwick, Coventry CV4 7AL, UK
[2]Department of Analytical Chemistry, Ghent University,
Krijgslaan 281 S12, B9000 Ghent, Belgium
[3]Institute of Mathematical and Physical Sciences, University of Wales Aberystwyth,
Ceredigion SY23 3BZ, Wales UK
m.g.dowsett@warwick.ac.uk, annemie.adriaens@ugent.be

X-ray absorption spectroscopy (XAS) is a non-destructive structural analysis technique which can be used to identify compounds such as corrosion products on metal surfaces. In contrast to the complementary technique X-ray diffraction, the analyte substance does not have to be crystalline, or even solid. For example, solutions of complex metal ions can be analysed. To analyse surface layers on a metal, one typically measures fine- structure in the X-ray fluorescence of the sample whilst sweeping the energy of the incident X-rays across an absorption edge. Nevertheless, X-rays with energies in the useful range for heritage metals such as copper, silver or lead are relatively penetrating, and implicitly analyze the top 10 μm or more of the sample. Signals from thin layers on the surface can be diluted or swamped by the bulk spectrum. An alternative, and relatively unexplored, source of XAS information lies in measurement of the visible and near-visible photon flux from the surface (ODXAS). These photons carry a huge amount of information across the range 200 nm -1000 nm, and some of this bandwidth is modulated in the same way as the X-ray fluorescence. However, these photons typically have a shoter range than the X-rays (~100 nm) and so the information is more surface specific.

Here we describe the use of ODXAS in conjunction with a novel electrochemical/ environmental cell developed for testing conservation techniques on heritage metals. Using data taken on the UK synchtron radiation source (SRS) at Daresbury we demonstrate the surface specificity of ODXAS and its superiority in detecting thin layers of nantokite and cuprite on copper compared to XAS. We show how these measurements form the basis of a new spectro-microscopy tool for observing the effects of, for example, conservation treatments and simulated corrosion in real time.