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A non-invasive in situ methodology to characterise the lacquers and metals from the *Edo period* Japanese armour

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Abstract

Japanese armour is thought to have evolved from the armour used in ancient China and Korea. Few are the works dealing with the characterisation of the materials used to create this appreciate artworks and most of them are focused on the characterisation of the helmet. In this work we present for the first time an in situ non-invasive methodology to characterise the composition of both metals/alloys and lacquers used to create a Japanese armour from the *Edo period* (1603-1869) property of the Armoury Museum of Alava (Basque Country, Spain). The armour was in situ investigated, without the necessity of taking any sample, for its later conservation in the Restoration Service from the Provincial Council of Alava (Basque Country, Spain). Firstly, by means of the use of a hand-held energy dispersive X-ray fluorescence spectrometer (HH-ED-XRF), the elemental composition of the metals/alloys of the armour was evaluated. This analysis determined that the *kabuto* (helmet) and the *dō* (cuirass) were made of at least seven different materials including their main body and decorations. Apart from the elemental characterisation and by using a portable Fourier Transform infrared spectrometer, which implements a Diffuse Reflectance sampling interface (DRIFT), the nature of the lacquer used in the armour was also determined (*urushi*). Thanks to the penetrating analysis that can be achieved using the HH-ED-XRF the nature of the substrate used to lacquer the armour was also approached. Moreover, portable Raman spectroscopy also assisted DRIFT results in the identification of later interventions (nitrocellulose) done in the lacquered areas avoiding any sampling process and further analysis in the laboratory.

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