THE APPLICATION OF μ-RAMAN SPECTROSCOPY IN ANALYSIS OF ARCHAEOLOGICAL OBJECTS

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The development of "laser-assisted" Raman spectroscopy has attracted attention as experimental technique suitable for the study of the wide variety of archaeological/art objects, due to a non-destructive approach in characterizing of physical and chemical properties of the materials. μ-Raman spectroscopy has proved invaluable for analyzing almost every kind of artefact, from gems to different painted materials, to dyed fibres and to ceramics and glasses. Its main advantages: non-destructiveness, possibility for analyzing very small samples, its high selectivity and sensitivity, opposed to very few disadvantages, mainly, high level of background fluorescence, positioned μ-Raman spectroscopy as one of the most important analytical and diagnostic tools for investigation of precious objects in art and archaeology.

To illustrate the applicability of this technique, several examples have been chosen: (1) identification of natural and synthetic pigments in variuos kinds of supports: wall paintings (frescos), icons, manuscripts, (2) identification of natural organic binding media: waxes, resins, casein, oils (3) study of dyes on fibres and (4) study of glazed ceramics and glasses.

The identification of pigments by Raman spectroscopy is today well elaborated and is based on the comparison between their Raman spectra and a database of reference spactra. Few useful reference libraries on mineral and natural pigments have been published in the recent years. Some reference spectra of binding materials, such as waxes, resins, gums, caseins and gums are also available.

μ-Raman spectroscopy was performed on a number of archaeologically important natural plant fibres which lead to a creation of reference library spectra. This technique is able to detect dye compound on a textile fibre. The Raman spectrum of the plane natural fibre can be successfully subtracted from the spectrum of the dyed fibre, yeilding to a spectrum of dyestuff alone.

This technique has wide application in the study of glazed ceramics and glass, as well. The emphasis of the method in the study of glazed ceramics and glasses by μ-Raman spectroscopy is on the degree of polymerization described through the index of polymerazation (I_p) of SiO_2 and a degree of cation inpurities. The index of polymerazation (I_p) is defined as a ratio between the integrated area of the band due to the bending Si-O-Si vibration (A_{500}) and band due to the stretching Si-O vibration (A_{1000}) in glazed ceramics and glasses.

In spite of numerous applications of μ-Raman spectroscopy in archaeology, there is still lack of awareness about its posibilities among the conservation scientists. This is expected to be overcome in the future since the interdisciplinary research in archaeometry lead to more close coopartion between art historian, museum workers, conservation scientists and archaeologist on one hand and chemists, geologists, spectroscopists, on the other.

It is expected that the application of the μ-Raman spectroscopy will increase in the future by the further instrumental development, particularly in the quality of the mobile, fibre-optic instruments. The implementation of the chemometric techniques in Raman data extraction and Raman data interpretation will additionally enhance its application in the study of artefacts.