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SERS analysis of Fuchsine and Diamond Green G on Ag nanoparticles prepared by photoreduction

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Micro- or non-destructive identification of synthetic organic dyes employed to color cultural heritage objects such as historical textiles, is a real challenge for conservator scientists. This is due to their inherent high tinting strength and consequent low concentration in the carrying matrix [1]. This fact severely limits the number of analytical techniques that can be efficiently and micro-destructively employed for their detection and unambiguous identification. Surface-enhanced Raman scattering (SERS) has been developed as a micro or non-destructive technique for the characterization of organic dyes in works of art [1]. The application of Ag nanoparticles produced by laser photoreducion [2], lead us to analyze and detect synthetic organic dyes directly “on the fiber” by SERS spectroscopy.

Synthetic dyes meant technological simplifications to the home and industrial textile production. Thus, their use was rather widespread. However, a lack of comprehensive scientific and conservation literature on these molecules could be linked to the fact that the attention on the characterization of contemporary works of art has been made just relatively recently [3].

In this work, wool fibers dyed with two synthetic dyes belonging to the triarylmethane group, Fuchsine and Diamond Green G, were investigated by SERS spectroscopy. None of these dyes could be detected by regular Raman spectroscopy. Therefore, the use of the SERS technique was necessary for their study on fibers.

Ag nanoparticles were prepared and immobilized directly on wool fibers by photoreduction of AgNO3 using a laser/micro-Raman coupled system [4] with excitation at 442 and 532 nm. SERS spectra were carried out directly of the fibers using different wavelengths (442 nm, 532 nm, 785 nm).

Both Ag nanoparticles prepared by photoreduction give rise to intense SERS spectra. However, excitation at 442 nm has the great advantage of form active SERS substrates in 10% of the time needed to prepare them by irradiation at 532 nm. In the case of fuchsine, best results were obtained at 442 and 532 nm, due to the pre-resonant effect at those wavelengths. However, as Diamond Green G absorbs at 623 nm, a pre-resonant effect exits when the SERS spectra at 785 nm.

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