SERS imaging and chemisorption studies of methylene blue dyeing of antimicrobial textile fibers

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Surface enhanced Raman scattering (SERS) spectroscopy has been extremely used to detect organic molecules adsorbed at metallic nanoparticles (NPs), typically Au and Ag.[1,2] Numerous works have reported the development of efficient SERS substrates based on plasmonic nanostructures to detect molecular probes in multiple domains.[1,2]
In the last decade, the textile industry has applied new techniques for the deposition/adsorption of nano-sized particles on textile fibres in order to enhance specific properties on the conventional fabrics.[3,4] These new functionalities that arise from the incorporation of metallic NPs on textile fibres make them good candidates in domains such as wound dressing, smart textiles, water treatment, biosensors and paper industry. In addition, textile fibres containing Ag NPs have been extensively explored as antimicrobial fabrics.[3,4]
This research shows that Raman imaging coupled with SERS can be used as an advantage in the monitoring of textile dyeing process, which is a critical stage in the manufacture process of fabrics.[5] Using linen fibres loaded with Ag NPs and then stained with methylene blue (MB), it was possible to map the local distribution of the MB dye in the fibres by Raman imaging and consequently the distribution of Ag NPs. MB was selected as the molecular probe not only as a model dye but also because it occurs in aqueous solution in the form of dimer or monomer species each having different characteristic optical absorption and Raman spectra. Our results demonstrate that by using Raman imaging, it is possible to distinguish the preferred adsorbate form on distinct types of nanocomposite fibres and their local distribution. This investigation allows to foreseeing the use of this technique in terms of quality control of antimicrobial Ag containing fabrics, which is a market in great expansion.

References

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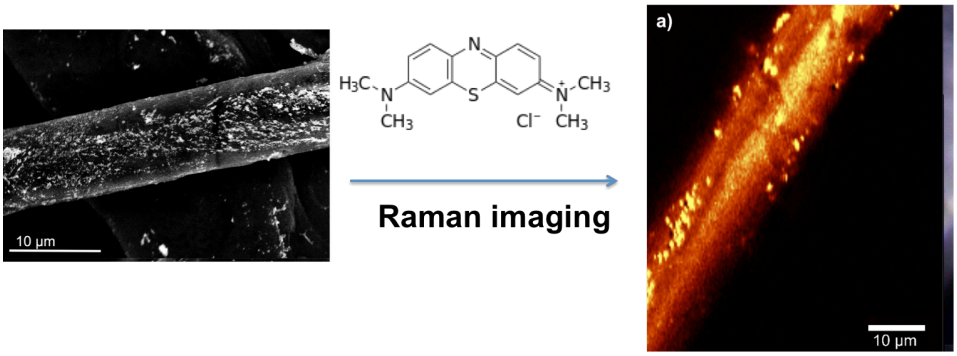

Figure: SEM image (left) and Raman image (right) obtained using the integrated intensity of the Raman band at 1620 cm^{-1} in the SERS spectrum of methylene blue 10^{-4} M using a linen based composite containing Ag nanoparticles as substrate (excitation at 633nm); chemical structure of MB (middle).