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Human Fingerprint Imaging by Scanning Electro-Chemical Microscopy (SECM)

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Fingerprints constitute a valuable tool for human identification because of their permanence and extreme discriminating power. The latter is thanks to the fact that fingerprints are characterized by a unique combination of specific features like the flow of the ridges (*i.e.* overall pattern), the ridge path deviations (*e.g.* ridge endings, bifurcations), and finally the intrinsic ridge characteristics (*e.g.* ridge shape, pores). As a consequence, forensic scientists have used fingerprint analysis for identification purposes for more than a hundred years. Human identity verification is obtained by the comparison of a fingermark found at a crime scene with the fingerprints collected on a suspect, or stored in a database. Therefore, the quality of the obtained image when imaging fingermarks is a major issue. Indeed, most of the time, marks left on touched objects and surfaces are not visible to the naked eye (*i.e.* latent fingermarks). This is due to the fact that they are composed of a mix of organic and inorganic compounds in small quantities which are deposited on the surfaces when touched by bare hands. During the last decades, the development of new techniques for fingerprint detection has been extensively pursued, since traditional methods of fingerprint detection may be unable to provide high quality images when dealing with not ordinary surfaces (*e.g.* multicoloured backgrounds, contamination with body fluids or other components, and porous surfaces).

Recently, it has been shown that visualization of latent fingermarks can be enhanced by using Scanning ElectroChemical Microscopy (SECM) combined with silver-staining (left side of the Fig.), benzoquinone tagging (right side of the Fig.) or multi-metal-deposition technology. In the first two cases the protocol is based on the staining of latent fingerprints by silver salts or benzoquinone, whereas in the latter case the latent fingerprint is coated first with gold nanoparticles that are then coated with silver by electroless deposition, allowing the fingerprint detection by the same principle showed on the left side of the Fig.

SECM provides the forensic scientist a new tool for the visualization of human fingerprints on unusual surfaces. In addition, fingerprint images are obtained with such a high resolution and sensitivity that information on pore shape and position can be easily obtained to be used for the identification process.

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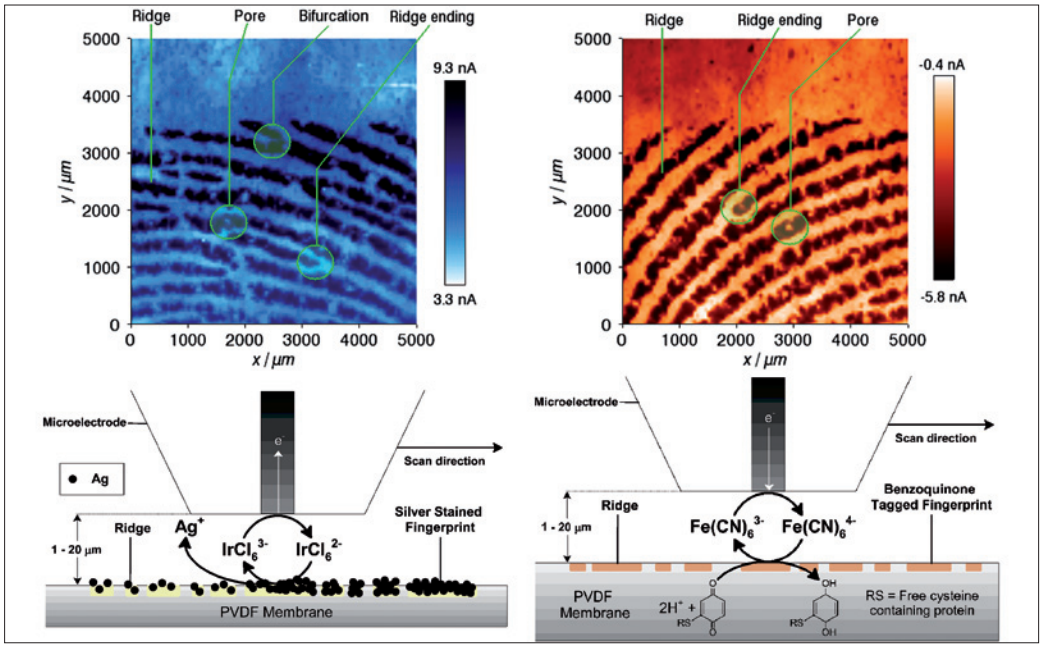

Top: Constant height SECM images of a fingerprint developed by silver staining (left) or benzoquinone tagging (right). Bottom: Schematic representation of the detection principle of silver nanoparticles containing fingerprints (left) and benzoquinone-tagged fingerprints (right).

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