A11 Electrophoretic Deposition of Nanoparticles and Nano-Structured Particles for Latent Fingerprints Detection on Different Surfaces

Roberto Rosa, PhD, Maria Cannio, PhD, Paolo Veronesi, PhD, and Cristina Leonelli, PhD, Dept Materials and Environmental Engineering, via Vignolese 905, Modena, 41125, ITALY*

After attending this presentation, attendees will be aware of the potential offered by Electrophoretic Deposition (EPD) of different kinds of nanoparticles and nano-structured particles in the development of latent fingerprints on a wide variety of porous and non-porous surfaces.

This presentation will impact the forensic science community by proposing for the first time the EPD technique in the development of latent fingermarks, and highlighting how nanotechnology and forensic sciences are becoming more and more intertwined.

Nanoparticles and nano-structured particles form the basis of several detection techniques for latent fingerprints and several reviews are yet available on this topic.[1,2]

Multimetal Deposition (MMD), for example, can be used for visualizing latent fingermarks on a wide range of porous as well as non-porous surfaces. MMD employs colloidal suspensions of gold nanoparticles, which preferentially deposit on fingerprint ridges, rather than in the valleys, through electrostatic and hydrophobic interactions.[3] Several works appeared later, aimed at enhancing the applicability of the MMD technique and trying to overcome its tedious experimental procedure, such as MMDII method, the use of functionalised and/or stabilised gold nanoparticles, and Single Metal Deposition (SMD).

Further nanoparticles and nanostructured particles employed for latent fingerprint detection include metal-oxides (such as TiO_2, ZnO, SiO_2, Fe_3O_4, and Eu_2O_3), sulfides, selenide, and tellurides, which were employed as pure powders or as fillers for nanocomposites in both Small Particle Reagent (SPR) techniques and dry powder dusting.

The goal of this presentation is to propose the use of electrophoretic deposition in place of or in combination with the aforementioned detection techniques based on the deposition of nanoparticles and nanostructured particles. EPD is a two-step electrochemical materials processing technique, usually carried out in a two electrode cell. In the first step, an electric field is applied between two electrodes and charged particles suspended in a liquid move toward the oppositely charged electrode (electrophoresis). In the second step, the particles accumulate at the deposition electrode and create a relatively compact and homogeneous film (deposition). EPD possesses several advantages over more conventional ceramic production strategies like short formation time, simplicity of the experimental apparatus, and almost no substrate shape restriction. Moreover, EPD can be applied to any solid that is available as a fine powder or as a colloidal suspension, including metals, polymers, ceramics, and glasses.

It is apparent that EPD techniques can be inserted into a latent fingerprint detection sequence. In this presentation, for example, it will be shown how aqueous EPD can play an innovative role after the first step of MMD. As known colloidal gold suspension creates a thin conductive layer perfectly reproducing the positive pattern of the fingerprint ridges. EPD can exploit this newly formed fingerprint-electrode to deposit a wide range of different ceramic nanoparticles in order to improve the contrast by changing the substrate background coloration.

It will be shown that electrophoretic deposition alone can also be exploited for latent fingerprint detection on metallic and semi-conductive surfaces. Indeed, the presence of a fingerprint residue alters the electrical conductivity of the substrate underlying the ridges. Thus, the effectiveness of the deposit will reflect this electrical discontinuity. In this framework, EPD may also be considered a valid alternative to vacuum metal deposition (VMD).

Several examples will be presented including the use of different ceramic nanoparticle suspensions on different porous and non-porous substrates. Preliminary results regarding the role of nanoparticles' morphology on their adhesion to fingerprint ridges, under the application of an applied electric field, will be presented as well.

References:

1. Choi MJ, McDonagh AM, Maynard P, and Roux C. Metal-containing nanoparticles and nano-structured particles in fingermark detection. *Forensic Sci Int* 2008; 179:87-97.
2. Hazarika P, and Russell DA. Advances in fingerprint analysis. *Angew Chem Int Ed* 2012; 51:3524-3531.
3. Saunders G. Multimetal deposition technique for latent fingerprint development, International Association for Identification, 74th Annual Educational Conference, June 1989, Pensacola, USA.

Latent Fingerprints, EPD, Nanoparticles

 ** Presenting Author*