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Preparation of hybrid nanoprobes from CdTe quantum dots, silver nanoprisms and silica for latent fingerprint detection

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The present study explored the application of fluorescent nanoprobes, derived from CdTe quantum dots (QDs) and silver nanoprisms (AgNPrs), for latent fingerprint identification (LFI). The combination of CdTe QDs with AgNPrs aimed to enhance their native fluorescence through the plasmonic effect. CdTe QDs were prepared in a hydrophilic colloidal medium using two stabilizers: 3-mercaptosuccinic acid (AMS) and cysteamine (CIS). AgNPrs were obtained by an adapted method from Aherne et al. (2008), where Ag seeds (10 - 15 nm) grow in the presence of polystyrene sulfonate $(PSS^-)_n$, inducing anisotropic growth and allowing the particle size control and plasmon band in the visible region. Hybrid materials were created by associating them with the hydrophilic silica matrix in dry form or as a suspended powder (spray) for application. QDs showed maximum absorption at 499 nm (d = 2.6nm) for CdTe_AMS and 530 nm (d = 3 nm) for CdTe_CIS samples, with emissions at 530 nm and 565 nm, respectively. Surface potential was negatively charged (ζ = -30.6 mV) for CdTe_AMS QDs and positively charged for CdTe_CIS QDs (ζ = 13.3 mV). TEM images of AgNPrs showed mostly prismatic flattened particles, d = 32 ± 6 nm and a mean width of 5 ± 2 nm. The surface potential of AgNPrs was ζ = -36 mV, attributed to $(PSS^-)_n$ chains on the surface. SEM and TEM images showed structures between 10 - 20 nm, resembling isolated silica morphology, but AgNPrs concentration in the materials was low. Emission of QDs after impregnation in silica showed a hypsochromic shift and reduced surface electric charge, suggesting interactions at the silica interface. However, emission intensity decreased, especially after adding AgNPrs. This phenomenon also occurred for CdTe_AMS/SiO_2 and CdTe_AMS/SiO_2 + AgNPrs samples, where emission maxima shifted to 567 nm and 539 nm, respectively. When staining latent fingerprints with synthesized nanoprobes, better revelations were observed (via fluorescence microscopy) for suspended CdTe_CIS nanoprobes. This is suggested to be due to better interaction with the fingerprint biological components, allowing level 2 features such as bifurcations and ponds to be seen. After impregnation in silica, hybrid materials showed intensive fluorescence suppression likely due to oxidative processes, and samples containing AgNPrs did not show efficient labeling due to low emission intensity [2]. It is suggested that, besides not observing a plasmonic effect, the AgNPs might have accelerated the oxidation of CdTe QDs. The study demonstrates the promising role of fluorescent nanoprobes in LFI but emphasizes the need to optimize the surface of hybrid materials to prevent oxidation when exposed to air.

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