Supplementary information

Carbon dots based nanopowders and their application for fingerprint recovery

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Experimental Section

Synthesis and characterization of C-dots

To synthesize C-dots we followed a protocol previously described in the literature[1]. In short, citric acid monohydrate (CA) and ethanolamine (EA) (both reactants were obtained from Aldrich) were mixed with a molar ratio 1 to 3. The mixture was treated at 180 ^{o}C for 30 min under reflux. The reflux condenser was then removed, the temperature was raised to 230 ^{o}C and the reaction was carried on for additional 30 min. The product was then cooled at room temperature, dispersed in water and was dialyzed against deionized water using SnakeSkin Pleated Dialysis Tubing membrane with a molecular weight cut-off of 3500 Da. C-dots, thus received, have diameter within the range 15-25 nm (S.I. Figure 1). In a previous report[1], elemental analysis indicated the presence of 44.85% C, 5.75% H, 10.85% N, while their quantum yield was estimated 15% relative to anthracene with λ_{ex}=365 nm.

Synthesis and characterization of biomass derived C-dots

The synthesis of biomass based C-dots is based on a method described previously by us[2]. In particular, 100 g of freshly collected grass were mixed with 1 l of water and then processed in a domestic blender. The mixture was then subjected to thermal treatment in an oven at 300 °C

for 4 h in air. The approximately 10 g of carbonaceous material thus produced was dispersed in water, refluxed in a 3 M HNO_3 solution for 48 h, centrifuged at 6000 rpm for 10 min at least three times and dialyzed against deionized water for several days using a Snake Skin Pleated Dialysis Tubing membrane with a molecular weight cutoff of 3500 Da. It has been reported[2] that the nanoparticles thus prepared have diameter within 25-30 nm and are composed by 48.57% C, 2.64% H, 6.98% N.

Preparation of mixed powders

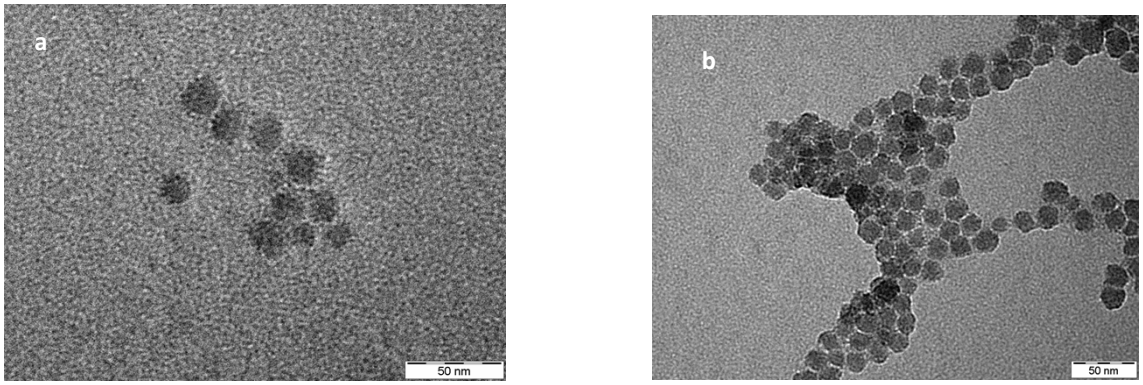
Colloidal silica Ludox HS-30 with a mean diameter of 18 nm was purchased from Sigma Aldrich. To prepare the hybrid powders, C-dots were added the dispersion (weight ratio 1 to 150), followed by freeze-drying. Alternatively, TiO_2 (Aldrich), laponite clay (Southern Clay Products) and a commercially available white fingerprint powder (K9 Scene of Crime Equipment Limited) were used. C-dots/laponite, C-dots/ white fingerprint powder and C-dots/ TiO_2 were prepared via freeze-drying in a similar manner. The quantum yield of C-dots/silica, C-dots/fingerprint powder, C-dots/laponite was estimated 15%, 14% and 10% respectively relative to anthracene with λ_{ex}=365 nm.

Fingerprint recovery

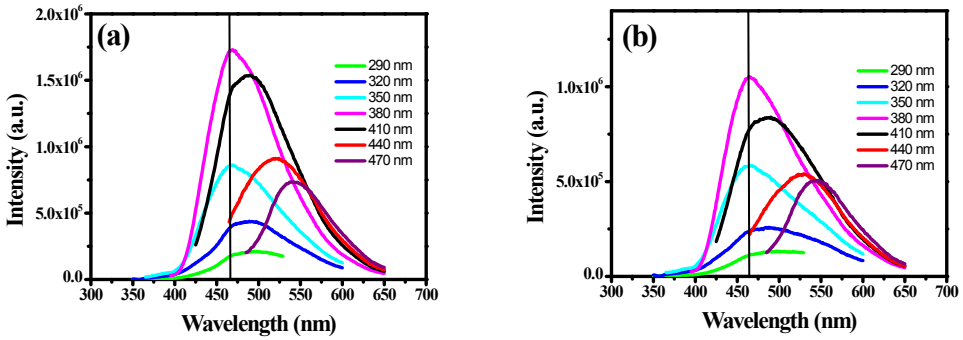
A squirrel-hair brush was used to apply the powders to fingerprints deposited on glass slides, polymers, papers, soft drink bottle foil and metal surfaces.

Fluorescence imaging

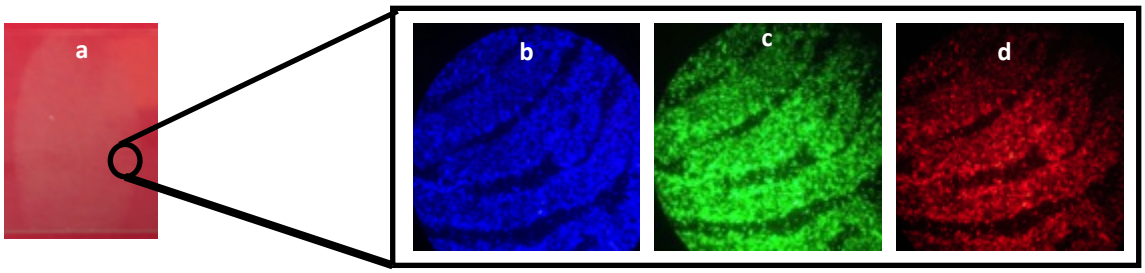
The fluorescence microscopy images were obtained via a Zeiss Axio Scope A1 microscope through band-pass filters of different wavelengths; UV excitation, blue excitation and green excitation (dapi, gfp, texas red, respectively).



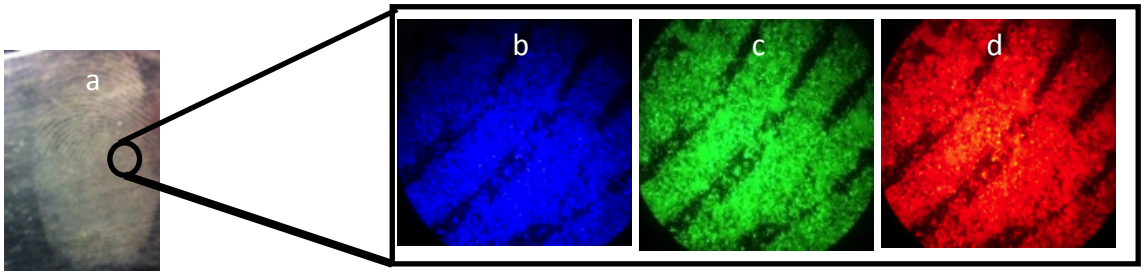
S.I. Figure 1. TEM images of C-dots.



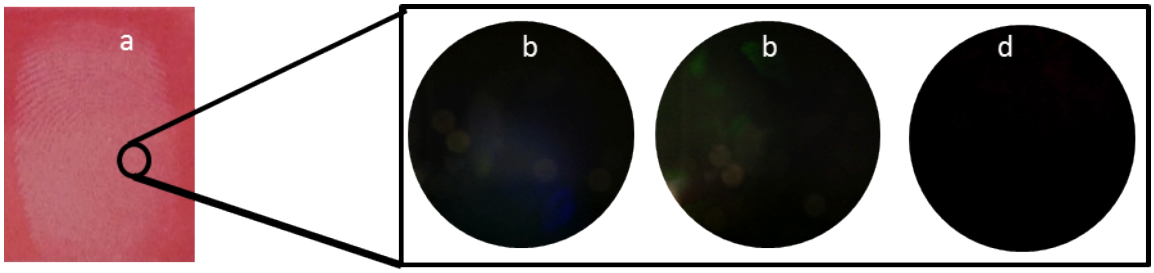
S.I. Figure 2. Photoluminescence spectra (under different excitation wavelengths) of aqueous dispersions containing 13 µg/ml C-dots in the presence of 150 times higher concentration of a) fingerprint powder and b) laponite.



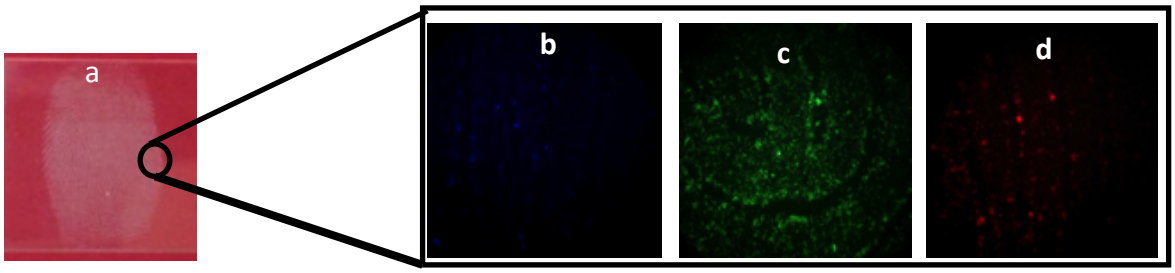
S.I. Figure 3. (a) Fingerprint deposited on a glass slide developed with 0.7wt% C-dots/ laponite and (b-d) fluorescence images (magnification x100) under UV, blue and green radiation, respectively.



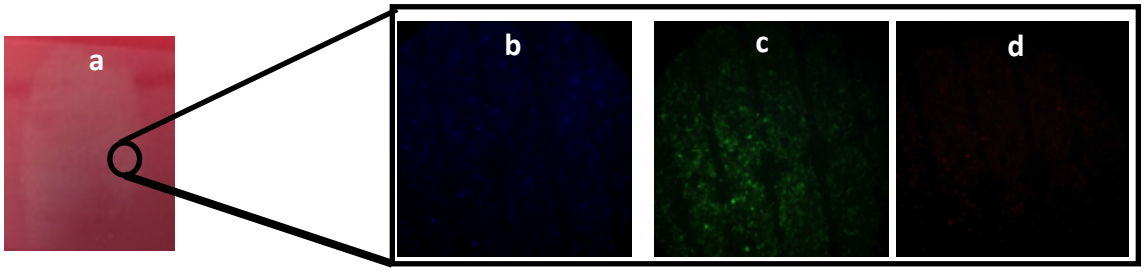
S.I. Figure 4. (a) Fingerprint deposited on a metal surface developed with 0.7wt% C-dots/ laponite and (b-d) fluorescence images (magnification x100) under UV, blue and green radiation, respectively.



S.I. Figure 5. (a) Fingerprint deposited on a metal surface developed with laponite and (b-d) fluorescence images (magnification x100) under UV, blue and green radiation, respectively.



S.I. Figure 6. (a) Fingerprint deposited on a glass slide developed with 0.7wt% biomass derived C-dots/$TiO_2$and (b-d) fluorescence images (magnification x100) under UV, blue and green radiation, respectively.



S.I. Figure 7. (a) Fingerprint deposited on a glass slide developed with 0.7wt% biomass derived C-dots/ laponite and (b-d) fluorescence images (magnification x100) under UV, blue and green radiation, respectively.

References

1. A. Kelarakis, M.J. Krysmann, P. Dallas, E.P. Giannelis *J. Am. Chem. Soc.,* 2012, **134**,747-750

2**.** A. Kelarakis, M.J. Krysmann, E.P. Giannelis *Green Chemistry*, 2012, **14**, 3141-3145.