Electronic Supplementary File

Carbon quantum dots decorated leaf-like CuO nanosheets and their improved dispersion for an excellent UV-shielding property in polymer film

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Experimental details

Preparation of CQD/CuO nanocomposite:

All the reagents were of analytical grade and were used without further purification. Typically for leaf-like CuO nanosheets, $CuSO_4.7H_2O$ (1.0 g) solution was prepared by dissolving in 100 ml of distilled water. The pH of the solution was adjusted to 12 using 0.1M NaOH solution and a clear blue colored solution was obtained (11.6 pH). Then, the clear solution was kept at 50 °C for 26 h, on standing. The black color precipitate was collected, washed with distilled water and dried at 300 °C in muffle furnace in air. The CQDs with the average particle size of ~ 2.5 nm were isolated from a wet chemical method. Concisely, carbon black pigment (50 mg, HIBLACK Orion) was refluxed with acid mixture (13 mL H_2SO_4 and 6.5 mL HNO_3) at 240 °C for 2 h and it was allowed to cool naturally to room temperature. Then, the reaction mixture was neutralized with sodium hydroxide (1M) solution at room temperature and excess salts were removed by repeated dialysis for 2 days.

For CQD/CuO nanocomposites, a required amount (10 µL) of CQD solution was mixed to the 25 mL of ethanol containing leaf-like CuO nanosheets (50 mg) and stirred for 30 min at room temperature. Filtered, washed with ethanol several times and dried at 80 °C for about 2 h.

Preparation of CuO/PMMA nanocomposite films:

Polymer films were prepared by dispersing few percentage of either leaf-like CuO nanosheets or CQD/CuO nanocomposites in polymethylmethacrylate (PMMA). Typically, for CQD/CuO nanocomposites film, 2.5 mg of CQD/CuO nanocomposites and 2.4 g of PMMA were taken in a beaker containing 10 ml of acetone. Allowed to stir for 30 minutes on a magnetic stirrer for homogeneous distribution of CQD/CuO nanocomposites. The subsequent viscose solution was transferred to a stainless steel plate, and it was allowed to stand for 5 hours. The representative polymer film containing 0.1 wt% of leaf-like CQD/CuO nanocomposites was designated as CC-1. Likewise, other polymer films, such as CC-2 (0.2 wt%), CC-3 (0.3 wt%), CC-4 (0.4 wt%) and CC-5 (0.5 wt%) were prepared in the same manner with different concentration of CQD/CuO nanocomposites. Similarly, for leaf-like CuO nanosheets polymer films, C-1 (0.1 wt%), C-2 (0.2

wt%), C-3 (0.3 wt%), C-4 (0.4 wt%) and C-5 (0.5 wt%) were obtained with different concentration of leaf-like CuO nanosheets, as specified earlier for comparison. In addition, a pure polymer film was prepared for reference. The thickness of the polymer was maintained to be ~0.35 mm.

Characterization:

The powder X-ray diffraction (XRD) patterns of the samples were recorded by a Rigaku using Cu Kα radiation (λ = 0.1546 nm) monochromated by a nickel filter. Morphology was investigated by field emission scanning electron microscopy (FESEM, SUPRA-40VP equipped with an EDXS system) and high resolution transmission electron microscopy (HRTEM, JEOL-2010). The surface electronic states were analyzed by X-ray photoelectron spectroscopy (XPS, AXIS Ultra DLD (Kratos. Inc), Monochromatic Al Kα radiation (1486.6 eV, 150 W). The optical property was analyzed with an UV-vis spectrophotometer (UV-2550, Shimadzu). The UV light absorption intensity was measured with help of UV light Digital meter (UV-340A, Lutron). Two different light sources, a UV lamp (18W, 365 nm) and direct daylight (Sunlight, 9-15th April 2015) were used to investigate the UV-shielding property. The particle distribution of nanocomposites in the polymer film was verified by confocal laser scanning microscope (LSM 510 META, ZEISS) with an Argon/2 laser-458,488 and 514 nm laser modules.

Additional Figures

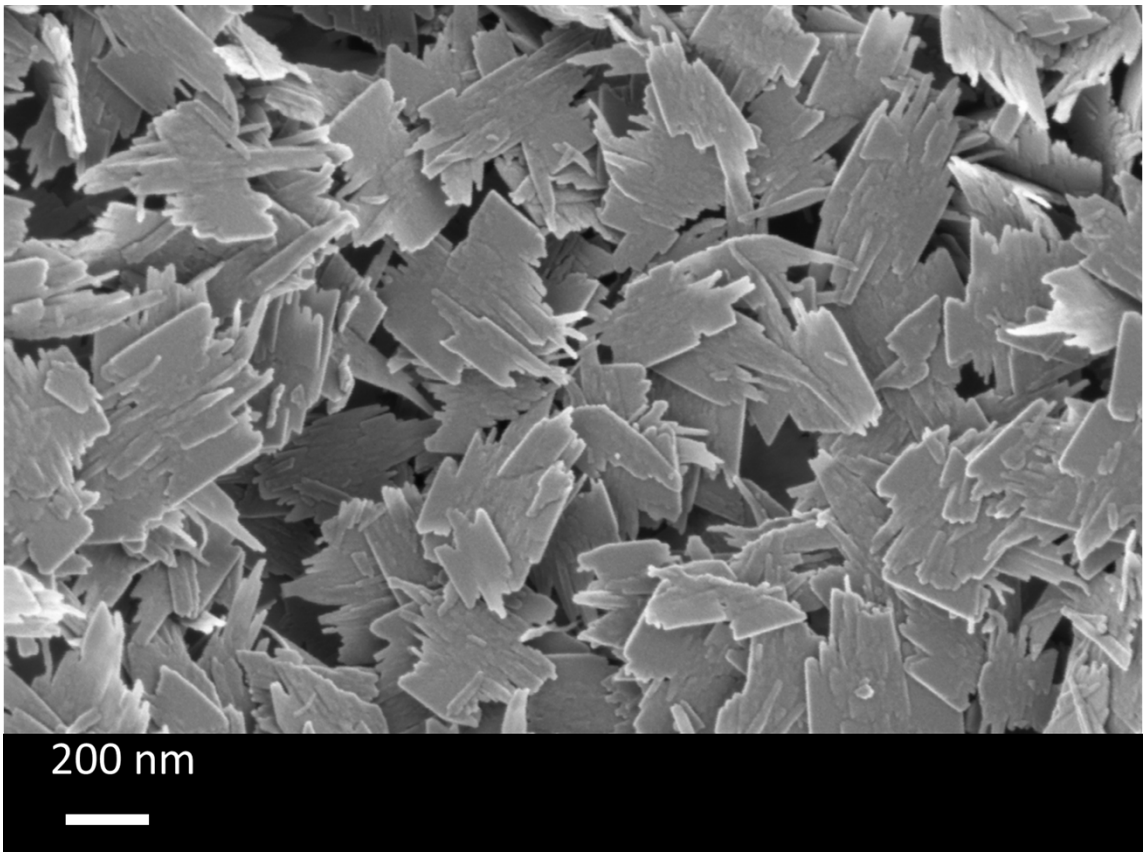

Fig. S1. FESEM image of leaf-like CuO nanosheets.

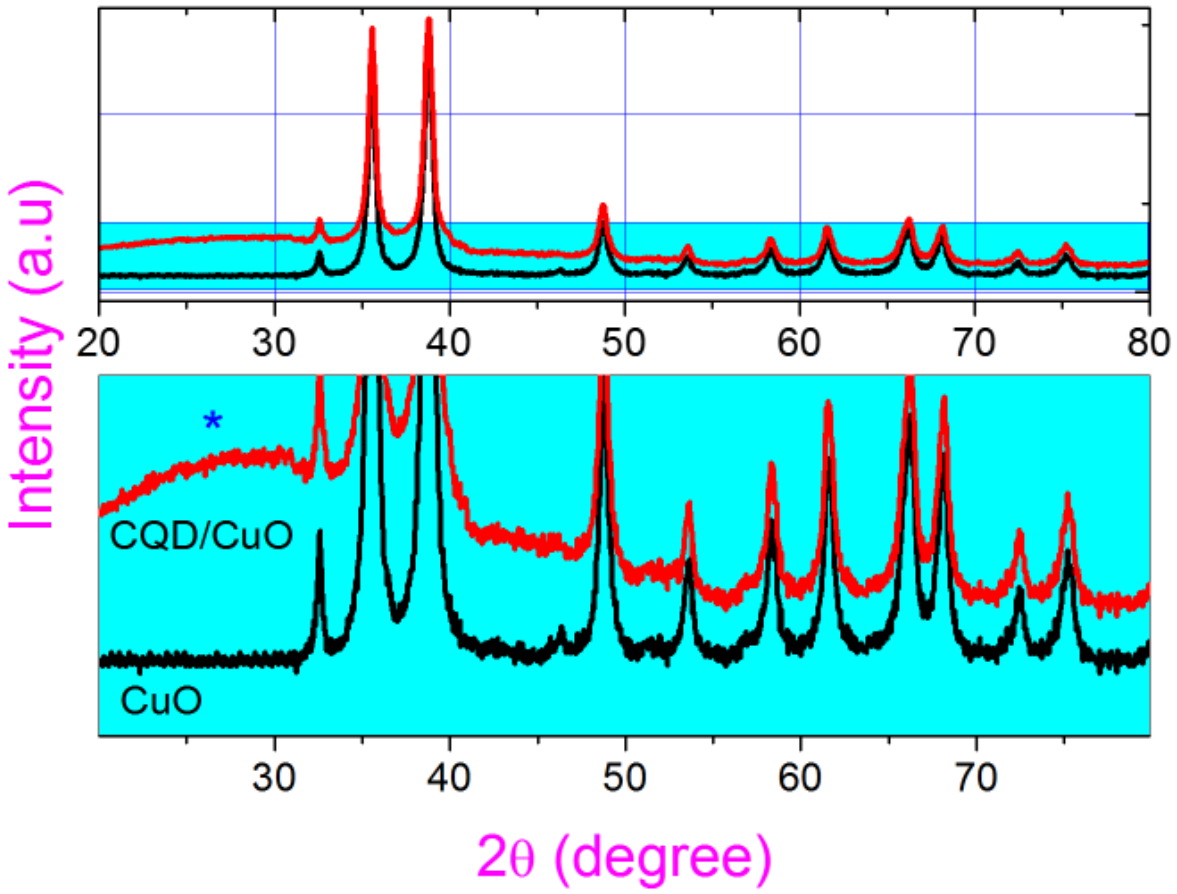

Fig S2. The zoomed XRD patterns of leaf-like CuO nanosheets and leaf-like CQD/CuO nanocomposites.

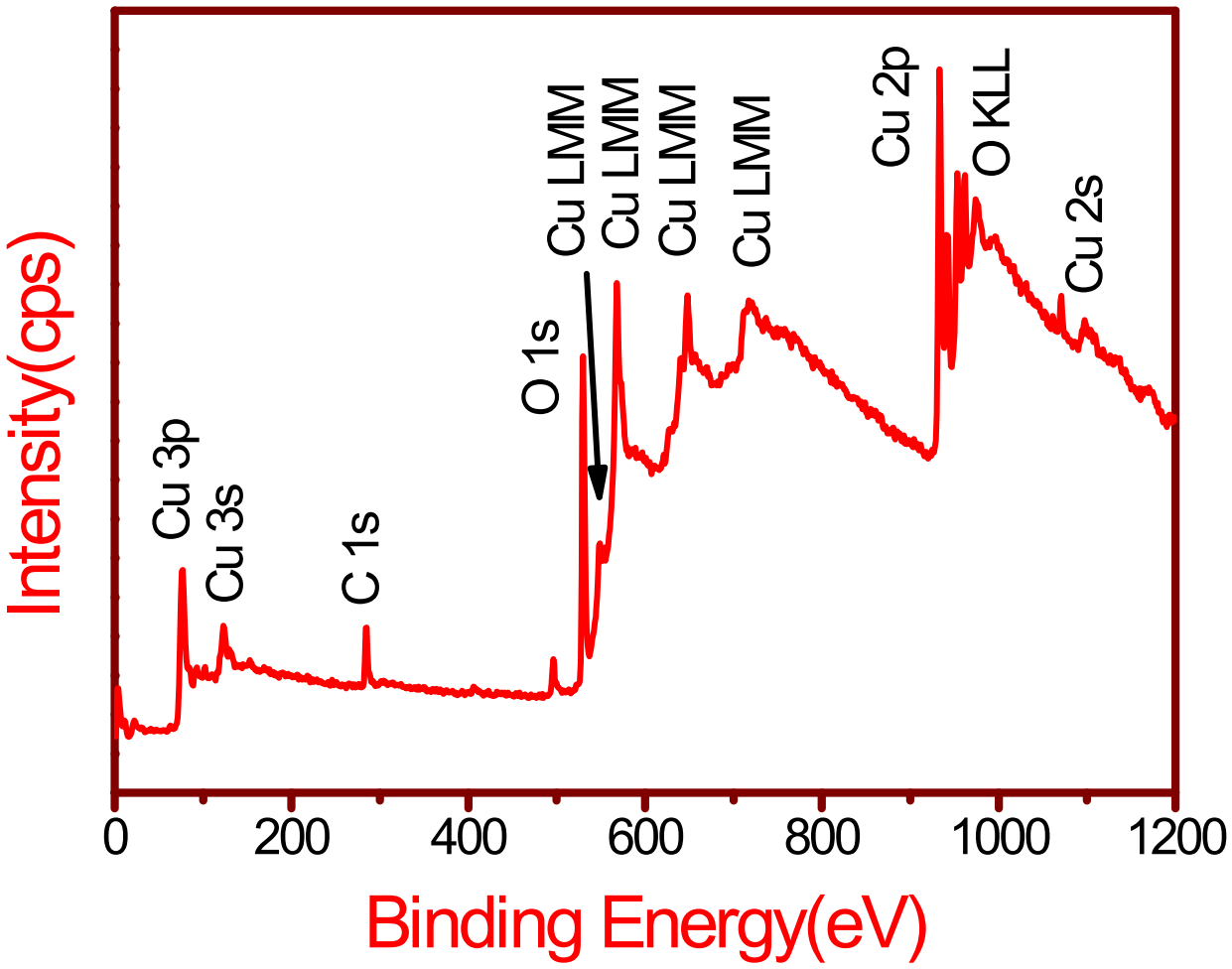

Fig. S3. Full survey scan XPS spectrum of leaf-like CQD/CuO nanocomposites

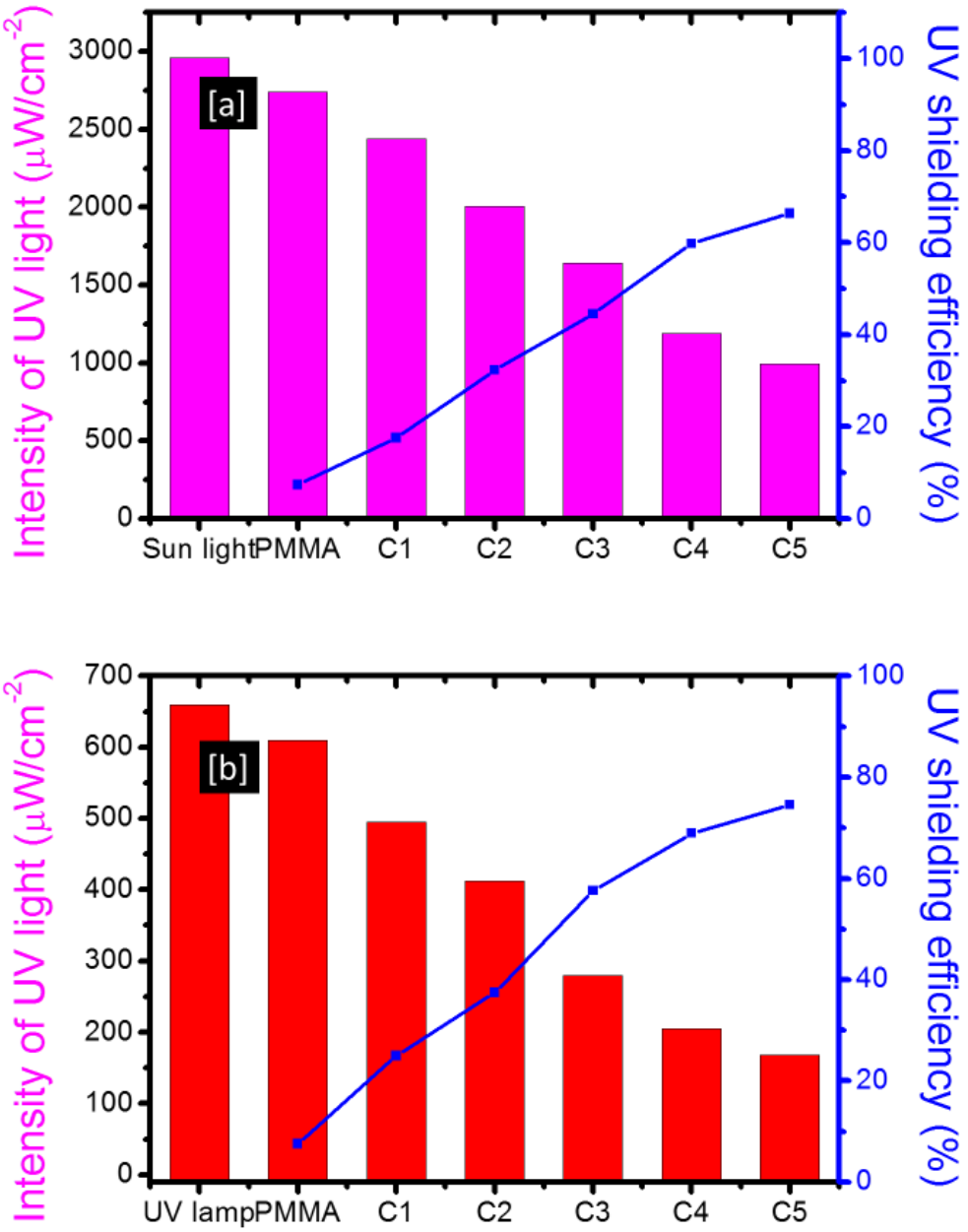

Fig. S4. The UV-shielding property of polymer films containing different percentage of leaf-like CuO nanosheets under (a) UV-lamp and (b) daylight sources.

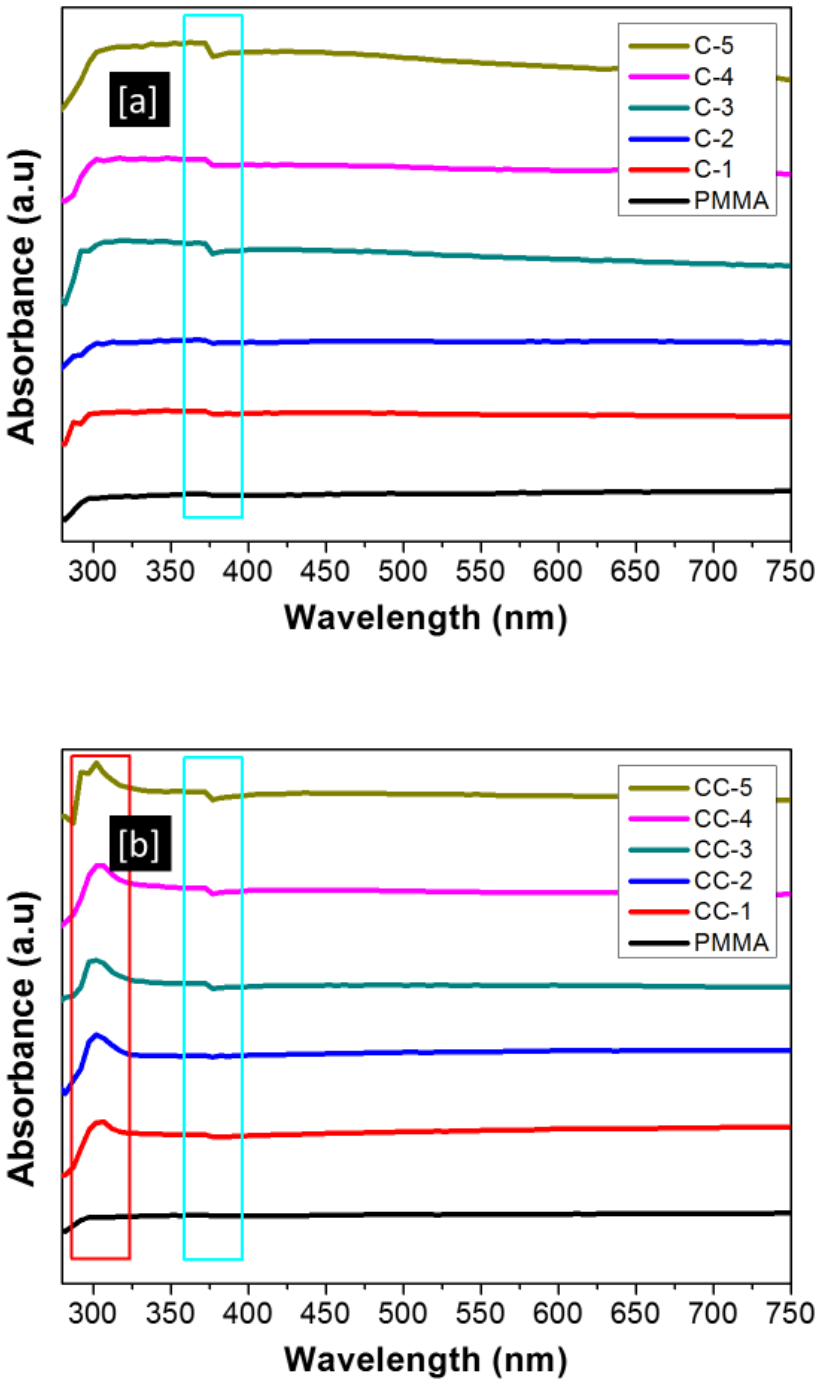

Fig. S5. The UV-vis absorption of polymer films with different weight percentage of (a) leaf-like CuO and (b) leaf-like CQD/CuO nanocomposites.

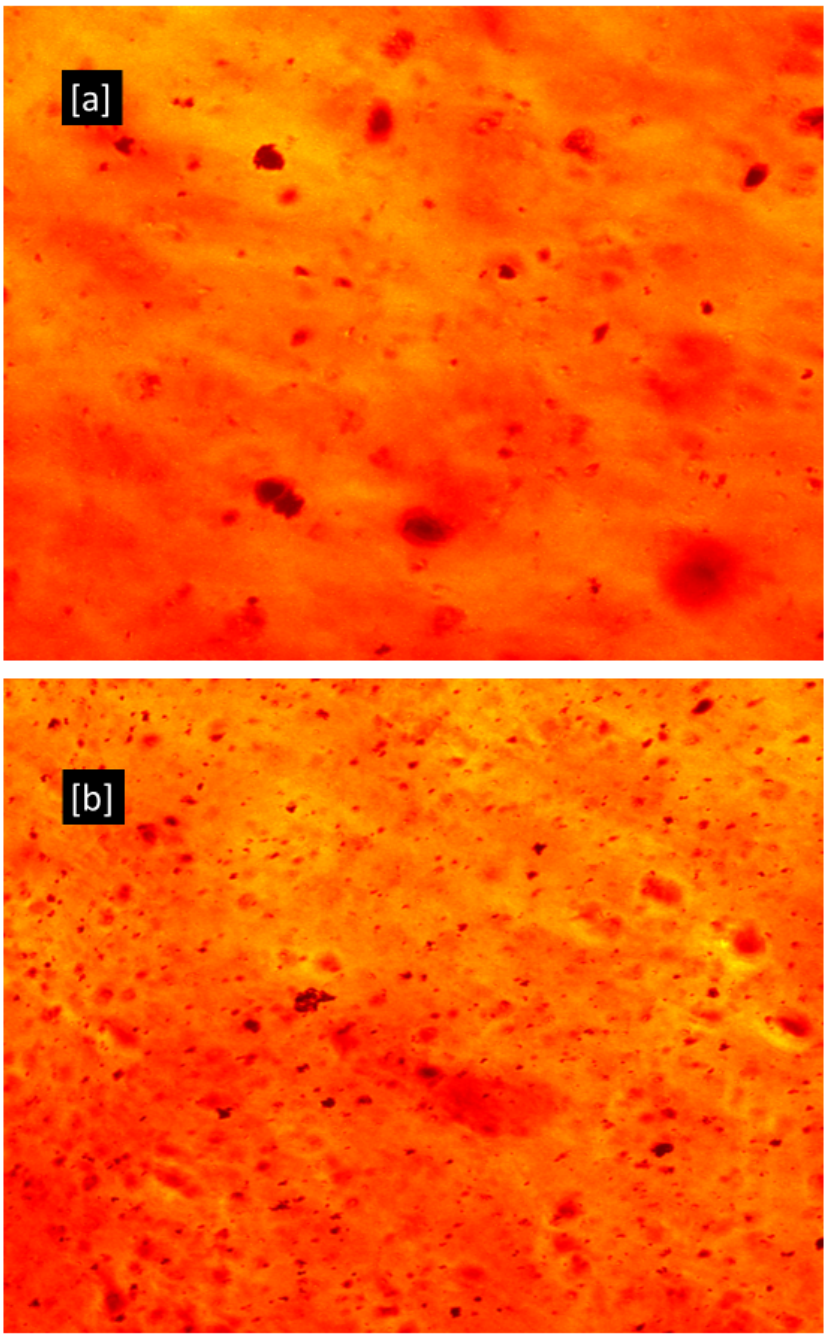

Fig. S6. The confocal laser electron microscopic images of (a) C-5 and (b) CC-5 films at an excitation wavelength of 488 nm with the 505-575 nm filter.