Eggshell Membrane Assisted CdS Nanoparticles for Manganese Removal in Water Treatment

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Material characterization

CdS sample phase composition was determined using a Bruker D8 Advance X-ray diffractometer (XRD, Billerica, MA, USA) (Cu K_α irradiation, 40 kV/40 mA, 0.02° 2θ step size and a scan time of 3 s per step) in the range of 20-70°. The morphology and composition of the CdS embedded on ESM sample were characterized using a scanning electron microscope (SEM) of Hitachi S3200N SEM, Tokyo, Japan coupled with energy dispersive spectroscopy (EDS; Oxford instrument elemental analysis). The transmission electron spectroscopy (TEM) analysis of the synthesized CdS nanoparticles was carried out using the JEOL 2100 TEM. X-ray photoemission spectroscopy (XPS) measurements were carried out in a PHI 5000 Versa probe II scanning XPS microprobe (ULVAC-PHI, U.S.). All spectra were recorded with monochromatic Al Kα (hν = 1486.6 eV) radiations with a total resolution of about 0.7 eV and a beam size of 100 μm. The absorbance spectrum of the CdS nanoparticles has been measured using a UV-Vis-NIR spectrometer (Lambda 1050, Perkin-Elmer). The room temperature emission spectra have been measured on a steady-state Spectro fluorometer (QM-40, Photon Technology International, PTI) using a Xenon lamp as an excitation source. The excitation wavelength was fixed at 320 nm, and a bandpass of 5 nm was used in all the cases. Zeta potential measurements were carried out on a Horiba Nanoparticle Analyzer-SZ100. Fourier transform-infrared (FT-IR) spectra were measured between 4000 and 400 cm^{-1} on a Perkin Elmer, Spectrum Two FT-IR spectrometer with a resolution of 4 cm^{-1} on the dried powder using potassium bromide (FTIR grade ≥99% trace metal basis, Sigma-Aldrich). The reduction comes degradation kinetics study of Mn^{VII} ion was performed by measuring the absorbance values at various intervals of time using a UV-visible spectrometer (Lambda 1050, Perkin-Elmer) at room temperature (25°C).

Catalytic efficiency Calculation

Catalytic efficiency = $[1-C/C_0] \times 100$
where C = final absorbance and C_0= initial absorbance.
C and C_0 have been considered for both $KMnO_4$ and MnO_2 absorption maxima.

Fig. S1. Schematic representation of ESM assisted CdS nanoparticle synthesis.

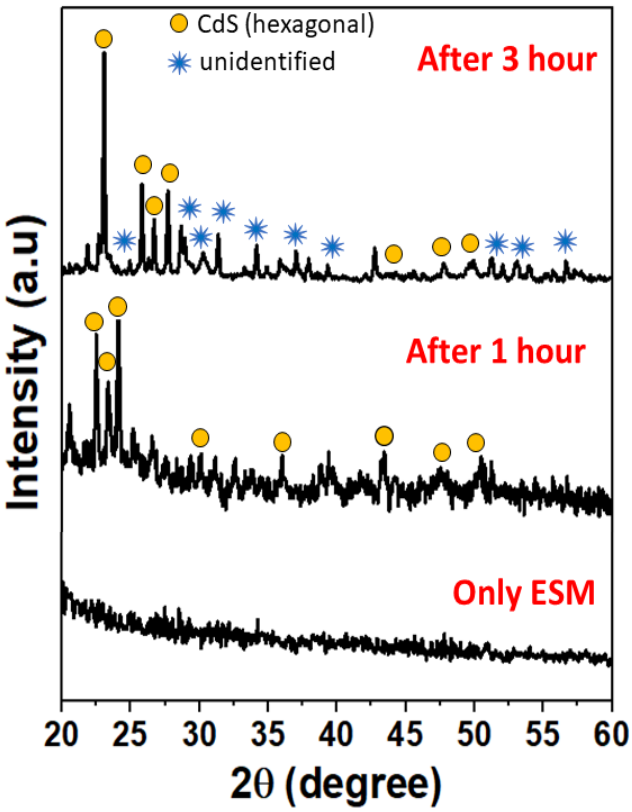

Fig. S2. X-ray diffraction of the pattern of only ESM and ESM derived CdS powder sample after 1 hour and 3 hour of UV irradiation, respectively.

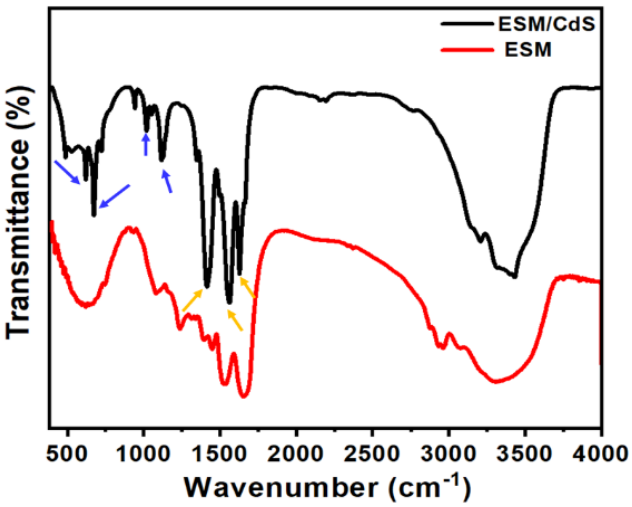

Fig. S3. FT-IR spectra of bare ESM and CdS nanoparticles immobilized ESM samples (yellow arrow represents ESM band; blue arrow represents CdS band).

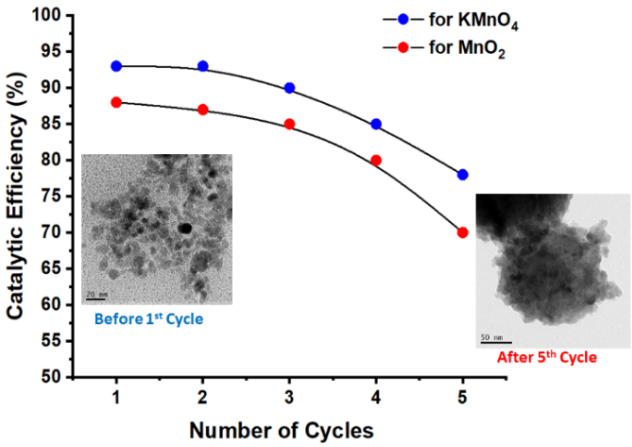

Fig. S4. Plot of catalytic efficiency of CdS nanoparticles as observed up to five cycles (inset: TEM bright-field images of CdS nanoparticles before the 1st cycle and after the fifth cycle test, respectively).