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ORIGINAL PAPER

Fluorescence quenching of molybdenum disulfide quantum dots for metal ion sensing

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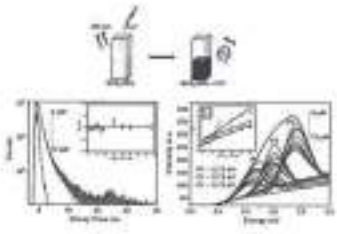
Abstract
In the present work, we have used hydrothermally synthesized in situ functionalized MoS_2-QDs for a sensitive (limit of detection ~ 2.06 μM) and selective detection of Fe^{3+} ions. A detailed study of fluorescence quenching behavior for MoS_2-QDs in the presence of Fe^{3+} ions has been performed using the Stern–Volmer plot, modified Stern–Volmer plot, and time-resolved photoluminescence measurements. Absorption based titration spectra and time-resolved photoluminescence measurements confirmed the fluorescence quenching is static with three decay times originated from the three different fluorescing sites. Interestingly, it is found that emission spectra consist of three bands at positions ~ 450 nm (P1, ~ 2.76 eV), ~ 475 nm (P2, ~ 2.61 eV), and ~ 503 nm (P3, ~ 2.46 eV). These peaks show a systematic quenching with the increasing concentration of Fe^{3+} ions. Quenching constants corresponding to these emission bands are found of the order of $\sim 10^3\ M^{-1}$. Large values of bimolecular quenching constants ($\sim 10^{11}\ M^{-1}\ s^{-1}$) suggest a strong binding interaction between MoS_2-QDs and Fe^{3+} ions. Furthermore, to understand the fluorescence quenching of MoS_2-QDs in the presence of Fe^{3+} ions, a ground-state complex formation-based mechanism has been proposed and elucidated in detail.

Graphic abstract



Keywords Fluorescence spectroscopy · UV/Vis spectroscopy · Nanostructures · Metal ion sensing · Time-resolved photoluminescence

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Self all corrected

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