CdSe/ZnS Quantum Dot-Gold Nanoparticle (QD-AuNP) Composites as New Catalysts for Photo-Redox Applications

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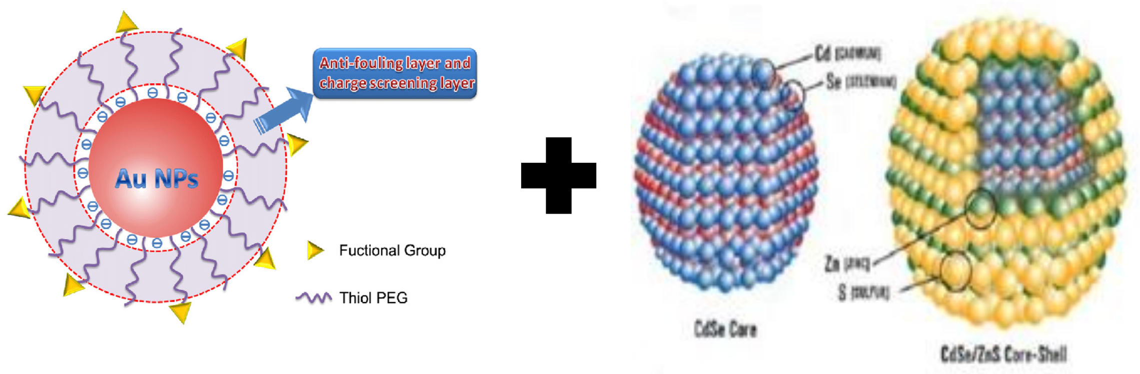
Introduction

Why catalysts in photo-redox reactions?

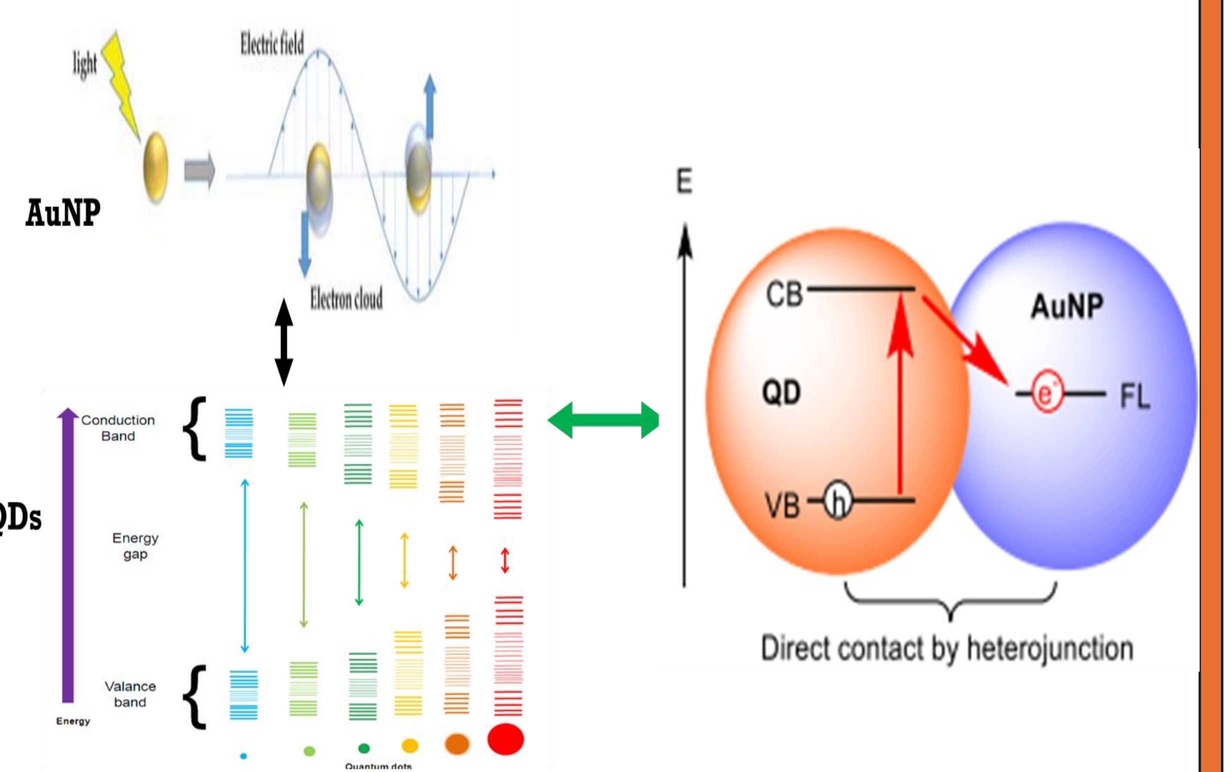
✓Catalysts can start photochemical reactions that would not be possible with conventional thermal processes

✓Photocatalysts *can absorb visible light* to overcome the constraints caused by the fact that many *organic compounds do not absorb visible light*



Therefore, in photo-redox catalysis, QDs can act as *light absorbers and charge donors,* while the AuNPs can act as *charge acceptors and catalytic sites*

Aim:



Methods

Synthesis and characterization of spherical gold nanoparticles

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Functionalization of Au nanoparticles using boronic acid

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Characterization and functionalization of CdSe/ZnS QDs using diol

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Assembly of CdSe/ZnS QD-Au nanocomposite

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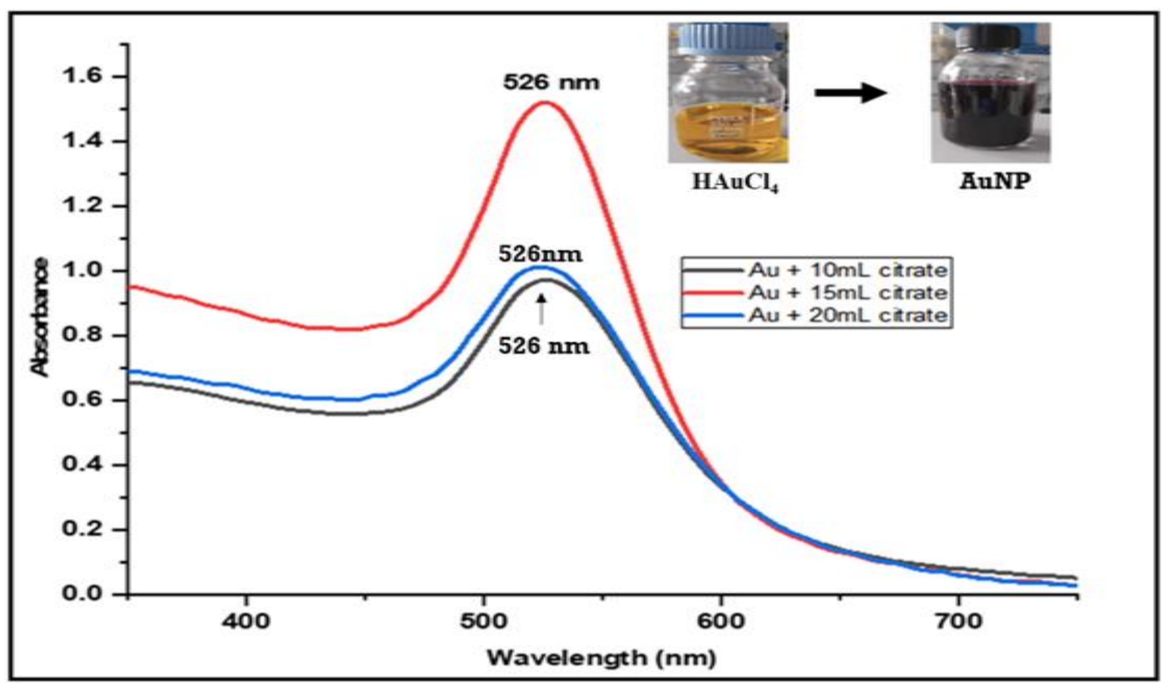
Quenching of QD photoluminescence in QD-AuNP composites

Results

❑Synthesis and characterization of AuNPs



UV-visible spectra of citrate-reduced AuNPs

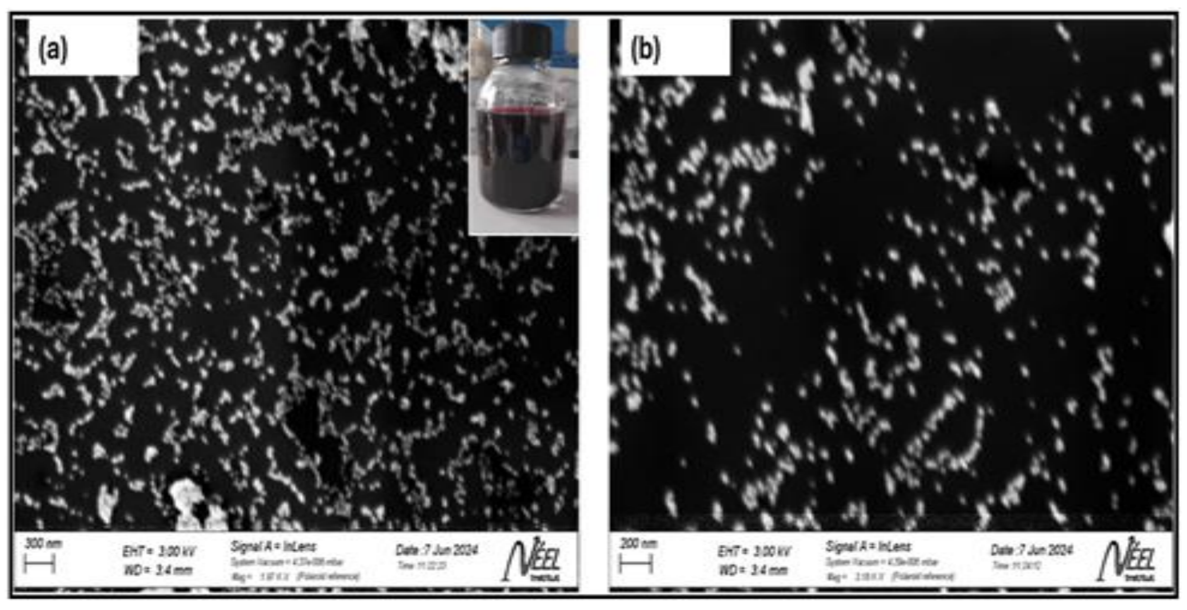


Figure 2: FESEM image of citrate-reduced gold nanoparticles (AuNPs) (a) 300 nm, and (b) 200 nm resolutions respectively (10 mL citrate)

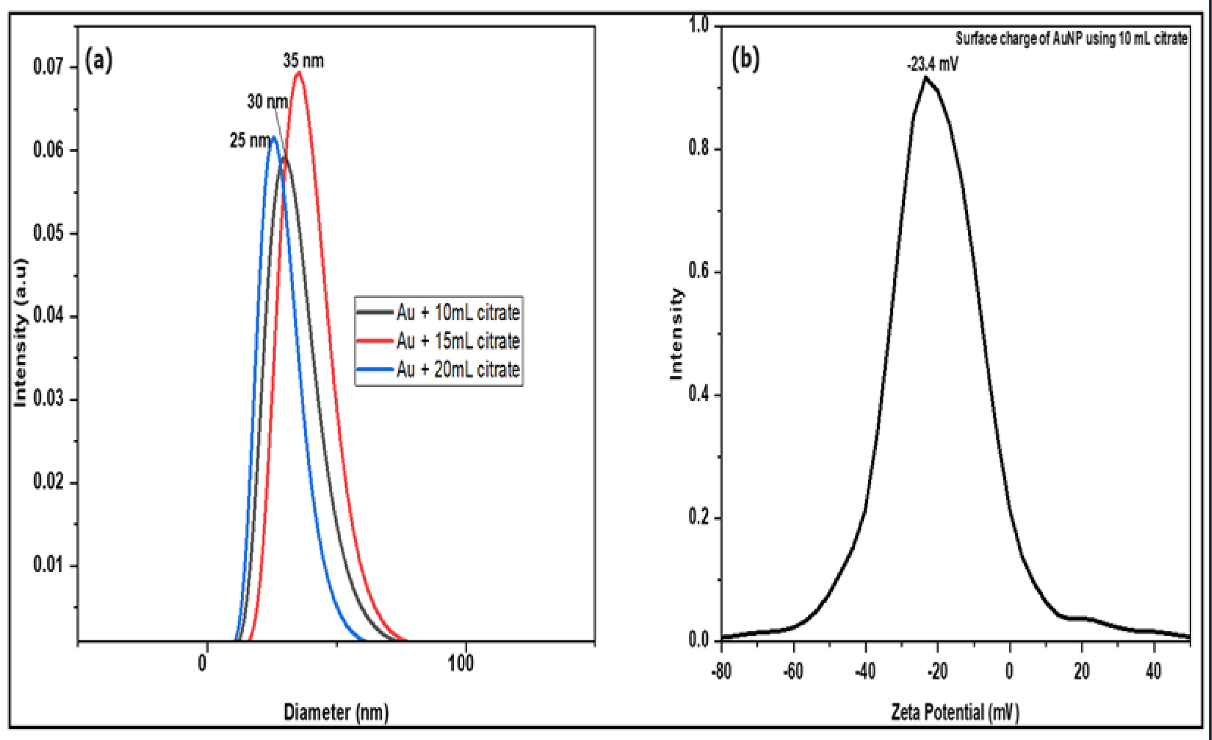


Figure 3: (a) DLS plot, and (b) Zeta potential of synthesized AuNPs

❑Functionalization of Au nanoparticles

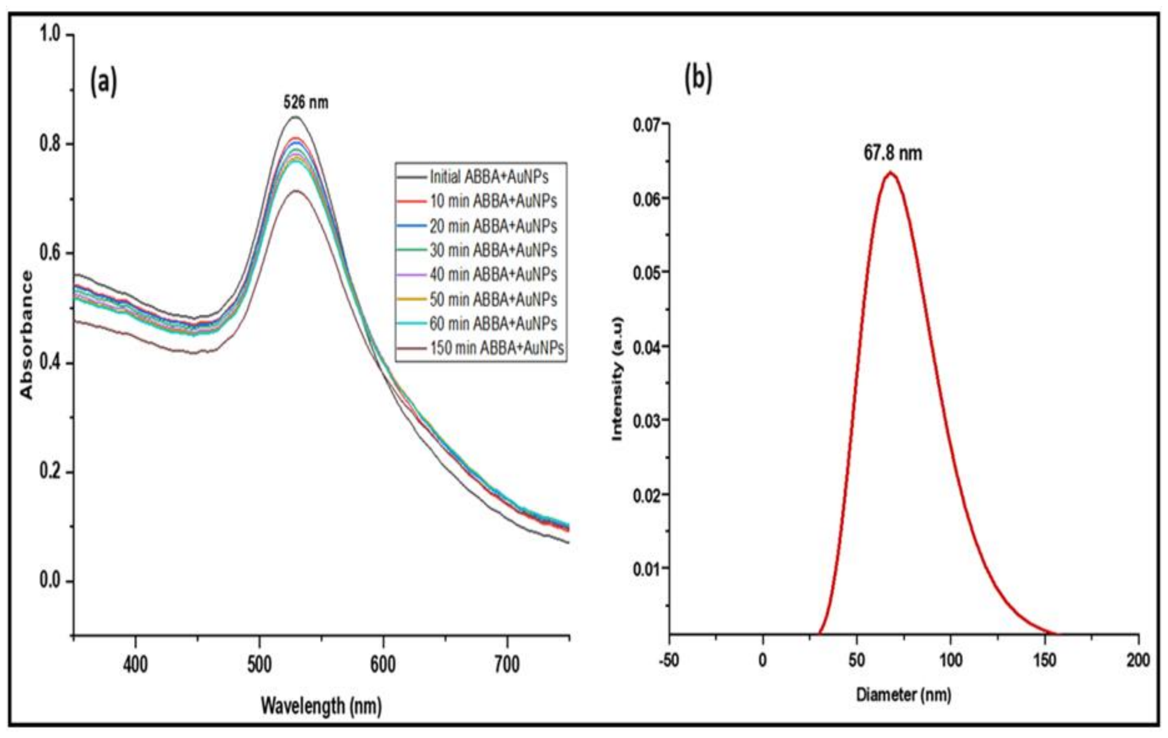


Figure 4: (a) UV-vis spectra, and (b) Dynamic Light Scattering (DLS) plot of 4-aminobenzene boronic acid-functionalized AuNPs

❑Commercial CdSe/ZnS core-shell QDs

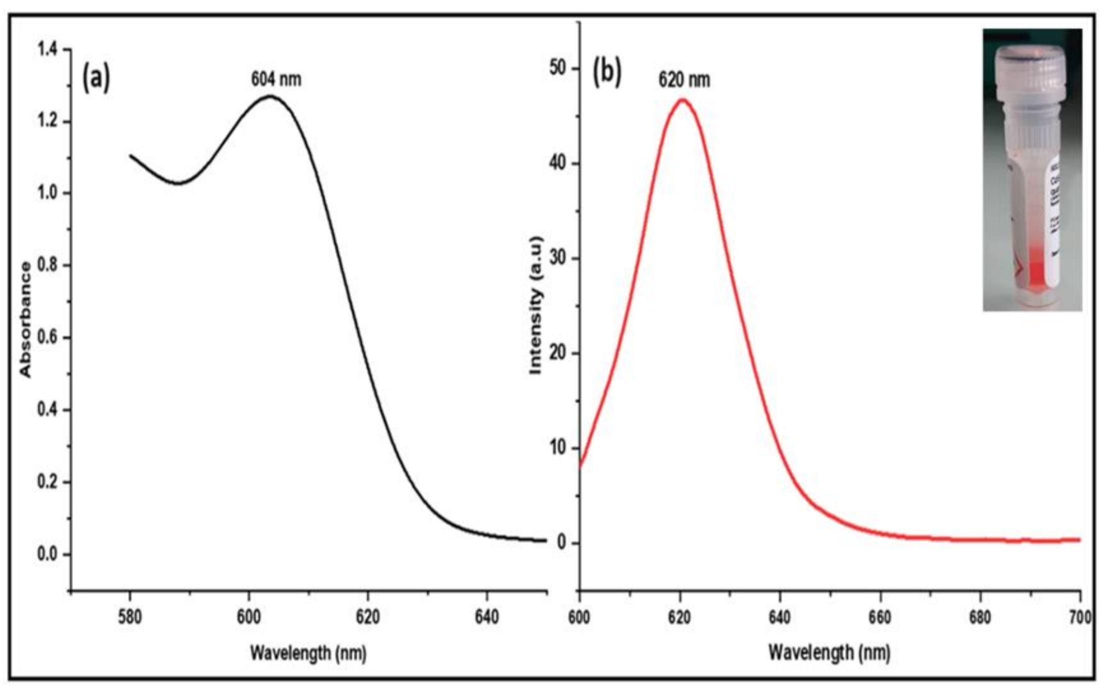


Figure 5: (a) UV-vis spectrum, and (b) fluorescence spectrum of commercial QD-COOH

❑Assembly of CdSe/ZnS QDs with Au nanoparticles

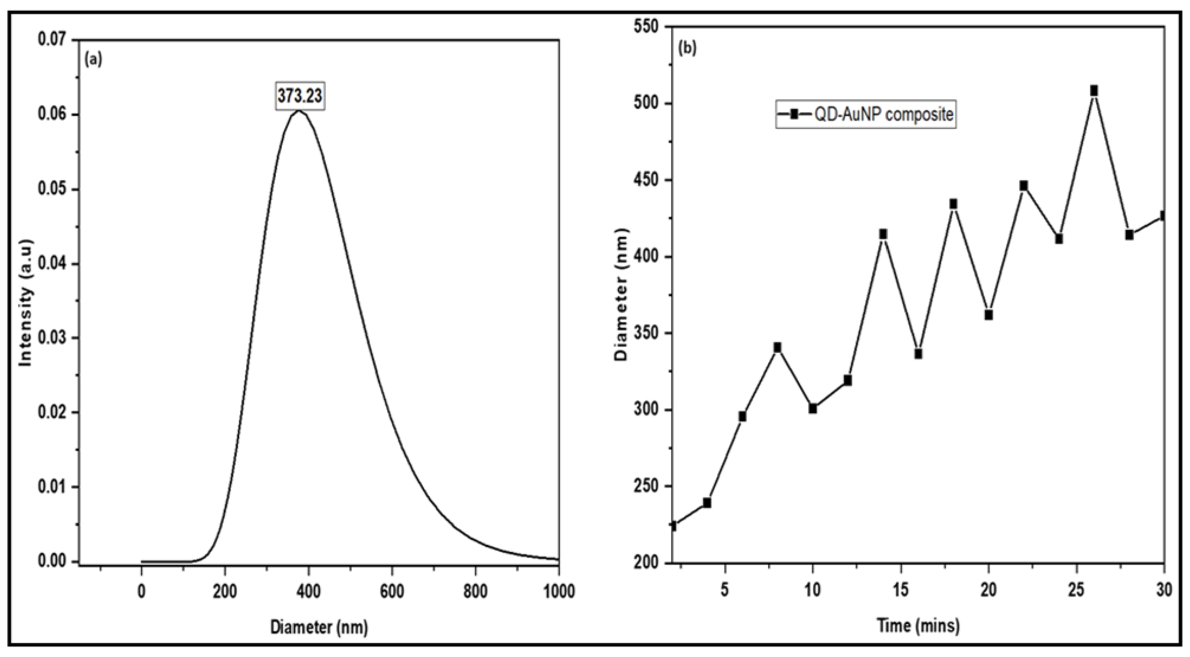


Figure 6: (a) DLS plot, (b) DLS kinetics of QD-AuNP composites

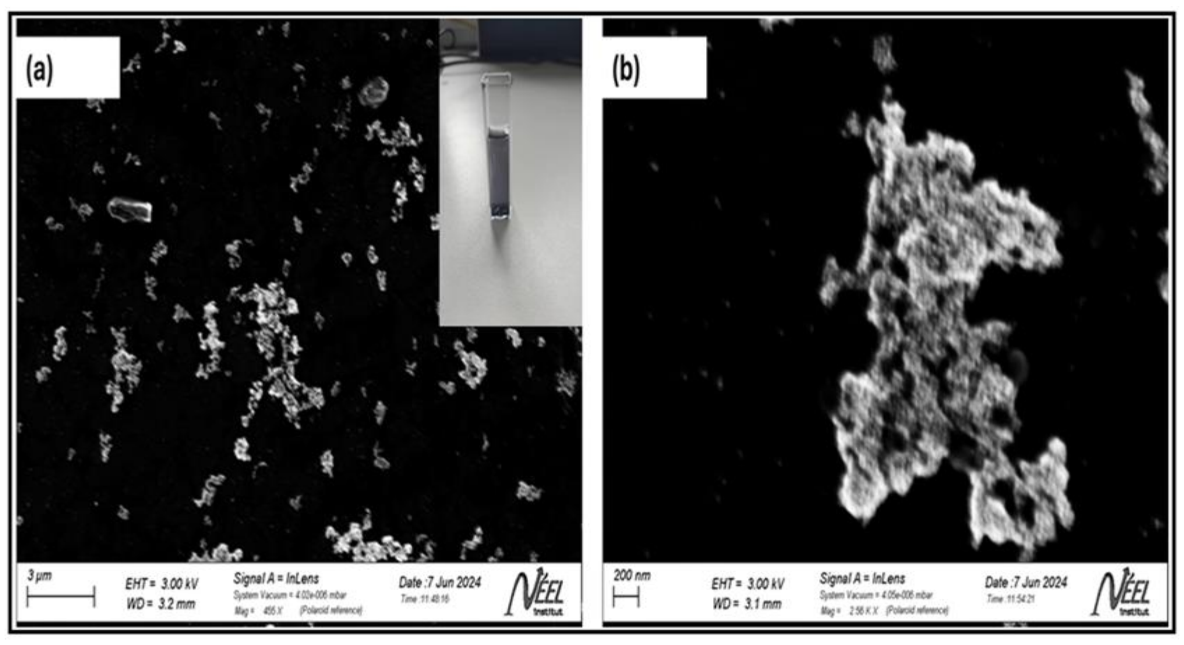


Figure 7: FESEM images of QD-AuNP composites (a) 3 µm, and (b) 200 nm

❑Quenching of QD photoluminescence in QD-AuNP composites

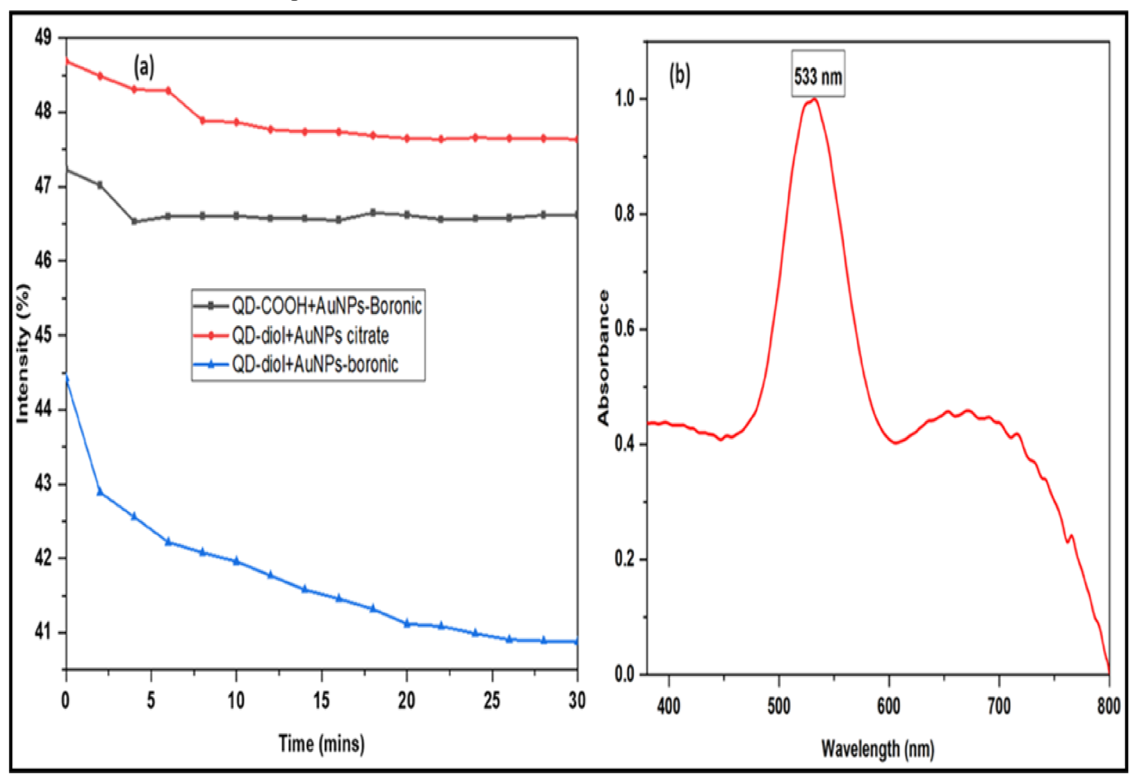


Figure 8: (a) Fluorescence intensity quenching of CdSe/ZnS QD as a function of time during the formation of the QD-AuNP composite in comparison with reference samples of QD and AuNP (without ligands). λ_{exc} = 580 nm, λ_{em} = 615 nm, (b) UV-vis spectrum of QD-AuNP composites

Conclusion

✓Successful covalent assembly of QD-AuNP composites linked by boronic acid-diol bonds.

✓An increase in the average size of the composite particles from about 220 nm to 500 nm within 30 mins, indicating the formation of large aggregates over time.

✓A significant quenching of QD fluorescence, with a 26.15 % decrease in photoluminescence intensity after 30 mins.

Reference

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