Abstract

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Title of the thesis: "Study of the Interactions of Gold, Silver and Molybdenum disulfide Nanostructures with Organic and Inorganic compounds towards the Development of Various Sensing and Biological Applications via Spectrofluorometric Method"

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Over the last few decades, nanotechnology has attracted great attention in the scientific community due to their potential in many practical and commercial fields. Currently, there is renewed interest especially on the noble metal nanoparticles (NPs) and 2-dimensional layered nanostructured materials, for their potential applications in the field of catalysis, sensing, antibacterial, antimicrobial etc. applications. Interactions of the noble metal nanoparticles such as gold, silver nanoparticles with organic fluorescent compounds show many interesting physical and physicochemical properties which implicate their potential in various technological fields. Among the various organic compounds, fluorescent dyes show many interesting diverse properties. Metal nanoparticles can significantly influence their photophysical properties in different microenvironment. On the other hand, 2D-layered nanostructured compound namely MoS_2 is also very promising because of their fluorescence emission properties and is now very attractive among the researchers. In this thesis, the interaction of gold and silver nanoparticles with some xenthane dyes in aqueous environment have been systematically studied. The unique change in fluorescence emission have been utilized for various bio sensing and biological applications. Hydrothermally synthesized nanostructured MoS_2 have been successfully utilized for mercury ion sensing both in solution as well as in intra-cellular medium and is presented in the thesis. The thesis is organized in various chapter. **First chapter** gives a general introduction, motivation and objectives of the research. **Chapter 2** briefly discusses the **theoretical background** of the research relevant to the work presented in this thesis. **Chapter 3** represents a **literature review** of the status of previous and recent relevant research works by various eminent scientists and researchers both at the international and national levels. **Chapter 4** deals with a detailed description of the **experimental methods and characterization techniques** used in the research work as presented in this thesis. **Chapter 5** demonstrates the sensing of important thiol (–SH) containing amino acid namely L-Cysteine (L-Cys) using citrate capped Au NPs and cationic dye RhB in aqueous solution via fluorometric assay method. The strongly quenched fluorescence of RhB due to Au NPs is selectively recovered by L-Cys accompanied with a distinct colour change and this fluorescence recovery was found to be highly sensitive to L-Cys concentration in aqueous medium. This sensing mechanism was successfully employed for the detection of L-Cys in the real bio-sample such as human urine as well. **Chapter 6** mainly focused on the comparative and selective interaction of the important amino acid D-Cysteine (D-Cys) with the colloidal Au NPs in the presence of a fluorescent probe namely RhB in their aqueous solution. D-Cys showed higher fluorescence recovery efficiency from Au NPs/RhB mixed aqueous solution along with a distinct colour change compared to the other relevant D- and L- amino acids, other thiol (–SH) containing biomolecules including L-Homocysteine, D-Homocysteine, Glutathione (GSH) etc. The proposed method of biosensing has also been tested with real bio-sample (human urine). **Chapter 7** describes the photophysical properties of xenthane dye acridine orange by silver nanoparticles in presence of biological molecule namely deoxyribonucleic acid (DNA). Silver nanoparticles strongly quench the fluorescence emission of dye molecules in presence of DNA whereas without DNA there was no significant change of emission was observed. Results revealed strong bonding of Ag NPs with DNA molecules in aqueous solution. **In chapter 8,** presents the study of fluorescence properties of MoS_2 nanoflakes for sensing of mercury ions (Hg^{2+}) in aqueous solution and in human cell (A549 and H9c2 cell lines) via selective fluorescence quenching mechanism. The proposed sensing method is highly sensitive towards Hg^{2+} ion when compared with the other metal ions in aqueous solution. **Chapter 9** presents the overall conclusion of the present thesis and future plan of research.

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