INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Programme of Study	:	**Ph.D.**

Thesis Title: **Crystalline Assembly of Gold Nanoclusters Mediated via Complexation Reactions**

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Thesis Submitted to the Department/ Center	:	**Chemistry**
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SHORT ABSTRACT
PhD Summary

Atoms, owing to the polarizability of the electrons, can be easily arranged into molecules. However, atomic nanoclusters, which in many aspects are similar to that of atoms, lacks the presence of polarizable electrons and hence are restricted from being spatially organized in a manner akin to that of arrangement of atoms to in molecules. In order to circumvent this limitation, the ligands stabilizing the nanoscale particles have emerged as an effective medium for spatial organization of theses nanoscale particles. For example, a large amount of effort has been invested in ligand mediated assembly of quantum clusters. In an allied vein, van der Waal's interaction based assembly of nanoclusters has also been pursued. These methodologies, though effective in spatial organization of nanoscale clusters with high ease of synthesis, have not led to emergence of superior properties of the assembly vis-à-vis the constituents.

To this end, designing an alternate approach for systematic assembly of nanoclusters, which would not only enable systematic organization of nanoclusters but also would endow the assembled clusters with intriguing properties, was deemed important. This approach was envisioned to originate from the knowledge of complexation reactions. The idea could be based on the fact that the ligands stabilizing the clusters could coordinate with metal ions and form inorganic complexes. This would not only allow facile formation of assembly of nanoclusters with well-defined structures but also invoke newer physical, optical and chemical properties to the clusters.

Thus, in my thesis, I have focused on synthesis and development of complexation reaction based crystalline assemblies of Au nanoclusters and exploring their application potentials.

At the very onset of my PhD work, I had developed a robust film based luminescence indicator of bilirubin, which could indicate hyperbilirubinemia through the thumb imprint of the patient. UV-light induced luminescence intensity of the film made out of chitosan stabilized gold (Au) nanoclusters, which was effectively quenched in the presence of Cu^{2+} ions, recovered in the presence of bilirubin in the skin or blood serum by virtue of complexation reaction between Cu^{2+} and bilirubin (deposited on the skin of the patient). Moreover, the sensitivity of detection of bilirubin was tunable with the amount of Cu^{2+} added, thereby facilitating the detection of desired amount of bilirubin.

With regard to systematic organization of atomic clusters and exploring their application potential, we have reported the formation of crystalline assembly of gold clusters, comprising of Zn^{2+} ions and ligands stabilizing Au_{14} nanoclusters. Analytical investigations including transmission electron microscopic analyses, X-ray diffraction analyses, Infra-red analysis, spectrophotometric analyses and computational modeling were performed to substantiate the structures of the crystalline assemblies. The crystalline complexes were found to exhibit superior luminescence vis-à-vis the non-assembled ligand stabilized gold nanoclusters. Importantly, the assemblies were effective for a myriad of applications like reversible gas storage (hydrogen and carbon dioxide) ambient conditions. Also, the storage of gases was accompanied by change in the luminescence of the assemblies which enabled visual sensing of adsorption and desorption process at a single particle level. Further the crystalline assemblies were used for chiral recognition and separation of enantiomers. Finally, the crystalline assemblies of gold clusters exhibited superior mitochondria targeted cancer theranostic activities as compared to non-assembled clusters.