INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: **Multifunctionalization of Nanoscale Particles for Cancer Theranostics**

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Thesis Submitted to the Department/ Center	:	**Chemistry**
Date of completion of Thesis Viva-Voce Exam	:	**12/11/2019**
Key words for description of Thesis Work	:	Multifunctional Theranostic Nanoparticles, Drug Delivery, Bio-imaging, Plasmonic Photothermal Therapy, Magnetic Targeting, MRI imaging

SHORT ABSTRACT

Cancer is a highly heterogeneous disease with inter-patient variations, which prevent conventional chemotherapy from being fully effective. In this thesis, the possibility of using multifunctional theranostic nanoparticles (MFTNPs) for simultaneous imaging, targeting and therapy of cancer cells *in vitro* is explored. This could be useful for addressing challenges arising out of inter-patient variations and to further develop personalized therapeutic strategies thus reducing the vulnerability and increasing the chance of patient survival. The main focus of the current thesis is the development of MFTNPs by unifying discrete "functional components" into a single nanosystem with the potential of simultaneously performing multiple task including multimodal imaging of the disease site, successful delivery and controlled release of the drug, providing with additional therapeutic module in the form of hyperthermia and magnetically targeted therapy *in vitro*.

The thesis addresses two different approaches for the fabrication of the MFTNPs. The first strategy employs biocompatible and biodegradable protein (like bovine serum albumin and lysozyme) matrices for the unification of different functional nanomaterials for fabricating the MFTNPs. In this approach, we have developed an ideal plasmonic and magneto luminescent MFTNPs by integrating the three main functionalities of inorganic nanomaterials namely magnetic, plasmonic and luminescent and demonstrated successful application of these MFTNPs in bioimaging, magnetic targeting, plasmonic photothermal therapy and drug delivery. On the other hand, in the second strategy, we explore the newly developed method of "surface complexation" on nanomaterials for the fabrication of a single nanocrystal based MFTNPs capable of possibly single particle-level bioimaging and cancer therapy.

The present thesis is comprised of six chapters. Chapter 1 provides an introduction of the thesis and literature review regarding the applications of nanomaterials in cancer theranostics. Chapter 2 describes the fabrication of multifunctional nanocarriers (MFNCs) by assembling gold nanorods, iron oxide nanoparticles, and gold nanoclusters within BSA nanoparticles and their use in drug delivery, bioimaging, magnetic targeting and MRI imaging. Chapter 3 discusses the fabrication of a plasmonic-magneto-luminescent multifunctional nanocarrier (PML-MF nanocarrier) by lysozyme-mediated agglomeration of gold-coated iron-oxide nanoparticles (IO@AuNPs) and subsequent coating of these agglomerates with BSA-stabilized gold nanoclusters (BSA-AuNCs) and their use in drug delivery, bioimaging, magnetic targeting and photothermal therapy. Chapter 4 demonstrates the fabrication of a novel class of magnetofluorescent theranostic nanoparticles (MFTNPs) based on 'surface-complexation' of zinc ferrite ($ZnFe_2O_4$) NPs with 8-hydroxyquinoline (HQ). This material was also used for cancer theranostics following loading of the drug artemisinin in it. Chapter 5 discusses fabrication of an ideal MFTNPs by complexation of zinc ions present on the surface of zinc ferrite nanoparticle with an anticancer derivative of HQ 8-hydroxy-2-quinolinecarboxaldehyde (HQCald) and finally demonstrated the capability for *in vitro* killing of cancer cells and single particle level bioimaging. Chapter 6 contains conclusion and future prospects.