

Preface

Medical scientists in the field of nanomedicine are exploring novel hybrid nanomaterials for efficient designing of multifunctional nanoflotillas [1]. Over the past few years, the combination of magnetic and plasmonic nanoparticles has drawn major interest due to their unique characteristics [2]. Undoubtedly, iron oxide nanoparticles were considered as an efficient flotilla, and the engineering of such a biomedical platform with a biocompatible surface coating, usually gold shell, provides stabilization under various physiological conditions. This modular design enables these nanoparticles to perform multiple functions simultaneously, such as in multimodal imaging, drug delivery, and real-time monitoring, as well as combined therapeutic approaches which serve as one of the most promising candidates for various biological applications [3].

In this thesis we have developed a multifunctional magneto-plasmonic core-shell nanoparticle by single and iterative seeding based methods. This nanocargo consists of an iron oxide nanokernel (Fe_3O_4 , CoFe_2O_4 , MnFe_2O_4) as a core and multiple layers of gold as a functionalizable active stratum. Gold-coated iron oxide nanokernel helps in augmenting the physiological stability and enhancing surface plasmon resonance property. We have also proposed a novel aspect of site-specific targeting of Doxorubicin using iterative core-shell nanoparticles as a nanopayload and folic acid as a targeting agent for cancerous cells. The gold coating and difference in shell size and shapes, have been well explained using XRD and HRTEM. HAADF-STEM and line mapping confirms the formation of core-shell structure. One single layer of gold offers the capability of binding drugs, but multiple coating further augments the physiological stability and tunes surface plasmon resonance as well as dielectrics for proficient loading of drugs as well as pH-dependent release in specific microenvironment. The functionalization of folic acid and Doxorubicin was confirmed by UV-Visible spectroscopy, FTIR, and TGA which confirmed the formation of noncovalent interactions. SQUID explained the efficacy of iterative method by confirming that even after the gold coating, the core-shell nanoparticles were highly superparamagnetic. The stability of nanoparticles was scrutinized by measuring the zeta potential, which was found to be in the range of -5 to -40 at different pH. The nanoparticle complex was found to be nontoxic for normal cells,

and considerably toxic for Hep2 cells detected by confocal microscopy and MTT assay. The drug loading capacity was found to be more than 80%. The targeted delivery of Doxorubicin using gold-coated iron oxide nanokernel as a nanopayload is demonstrated in this thesis. Drug release was carried out at three different pH like 5.4, 6.8, and 7.4 and found that at pH 5.4 the release is maximum which is favorable for cancer cell treatment. Doxorubicin release kinetics profile has been fit based on Zero-order, First Order, Higuchi, and Hixson-Crowell model. MRI showed that core-shell nanoparticles possess enhanced T_2 contrast for imaging both normal and cancer cells. Microwave-based magnetic hyperthermia studies exhibited an augmentation in the temperature due to the transformation of radiation energy into heat at 2.45 GHz. There was an enhancement in cancer cell cytotoxicity when hyperthermia combined with chemotherapy. Hence, this single nanopatform can deliver 3-pronged theranostic applications, viz. targeted drug delivery, MR imaging, and hyperthermia. This drug delivery system can act as an efficient nanocarrier in the cancer micromilieu for synaphic targeting, diagnosing, and killing of the cancer cells, thus rescuing the life of patients.

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References

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Design and Evaluation of Plasmonic/Magnetic
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