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Lipid-Coated Magnetic Nanoparticles for Frequency Triggered Drug Delivery

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Abstract : Superparamagnetic Iron Oxide Nanoparticles (SPIONs) have become increasingly important materials for separation of specific bio-molecules, drug delivery vehicle, contrast agent for MRI and magnetic hyperthermia for cancer therapy. Hyperthermia is emerging as an alternative cancer treatment to the conventional radio- and chemo-therapy, which have harmful side effects. When subjected to an alternating magnetic field, the magnetic energy of SPIONs is converted into thermal energy due to movement of particles. The ability of SPIONs to generate heat and potentially kill cancerous cells, which are more susceptible than the normal cells to temperatures higher than 41 °C forms the basis of hyerpthermia treatement. The amount of heat generated depends upon the magnetic properties of SPIONs which in turn is affected by their properties such as size and shape. One of the main problems associated with SPIONs is particle aggregation which limits their employability in in vivo drug delivery applications and hyperthermia cancer treatments. Coating the iron oxide core with thermally responsive lipid based nanostructures tend to overcome the issue of aggregation as well as improve biocompatibility and can enhance drug loading efficiency. Herein we report suitability of SPIONs and silica coated core-shell SPIONs, which are further, coated with various lipids for drug delivery and magnetic hyperthermia applications. The synthesis of nanoparticles is carried out using the established methods reported in the literature with some modifications. The nanoparticles are characterised using Infrared spectroscopy (IR), X-ray Diffraction (XRD), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM) and Vibrating Sample Magnetometer (VSM). The heating ability of nanoparticles is tested under alternating magnetic field. The efficacy of the nanoparticles as drug carrier is also investigated. The loading of an anticancer drug, Doxorubicin at 18 °C is measured up to 48 hours using UV-visible spectrophotometer. The drug release profile is obtained under thermal incubation condition at 37 °C and compared with that under the influence of alternating magnetic field. The results suggest that the nanoparticles exhibit superparamagnetic behaviour, although coating reduces the magnetic properties of the particles. Both the uncoated and coated particles show good heating ability, again it is observed that coating decreases the heating behaviour of the particles. However, coated particles show higher drug loading efficiency than the uncoated particles and the drug release is much more controlled under the alternating magnetic field. Thus, the results demonstrate that lipid coated SPIONs exhibit potential as drug delivery vehicles for magnetic hyperthermia based cancer therapy.

Keywords : drug delivery, hyperthermia, lipids, superparamagnetic iron oxide nanoparticles (SPIONS)
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