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Dissertation Announcement

MANIPULATION AND DETECTION OF MAGNETIC NANOPARTICLES FOR BIOMEDICAL APPLICATION

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Magnetic nanoparticles (MNPs) have been used in a wide range of *in vivo* biomedical applications utilizing their unique properties. One of the distinctive advantages of using MNPs is the transparency of tissues to magnetic fields which allows for many non-invasive applications. The functionalized MNPs could be attached to biochemical substances and then be used as biomarkers and carriers because the particles can be detected by magnetic sensors and they can be manipulated by a magnetic field.

The manipulation of the MNP carriers allows the targeted delivery of biochemical substances, such as drugs and imaging agents. Magnetic force created by various devices can be used to guide the magnetically labeled carriers to a target site. By using these targeted carriers, the efficiency and specificity of the delivery of the drug can be improved. To generate sufficient magnetic force for effective retention of MNP carriers in a flow, the magnetic field and field gradient created by the magnetic capture device (MCD) needs to be optimized. In this work, various designs of MCD were studied. A prototype MCD for concentrating MNPs was constructed and evaluated in various flow models. Works also focused on the detection of MNP-labeled biomarkers. The reliable detection of MNPs would bring enormous potential for improving the technologies on biomedical diagnosis and drug development. A biochemical substance labeled with MNPs can be used to non-invasively monitor biochemical processes at the cellular and molecular level. Minute magnetic field perturbations associated with these MNP biomarkers can be measured by various magnetic sensors. Superconducting Quantum Interference Device (SQUID) sensor is found to be suitable for detecting MNPs of nano-gram (ng) iron in a relatively large (cm) distance. Here, novel SQUID-based magnetic sensing technique was developed and applied for the detection of MNP samples in an unshielded environment. The spatially resolved magnetic images and time-varying magnetic traces from various MNP samples of few hundred ng were obtained. The detection limitations were investigated based on the signal-to-noise ration (SNR). In addition, the magnetic relaxation signals of various MNP samples including MNP-loaded tissue samples were obtained. The relaxation behaviors of the MNPs in different applied fields, temperatures, and suspension concentrations were studied.

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