AD06

Magnetic Nanoparticles for Biomolecular Detection, Manipulation, and Imaging

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Magnetic nanotechnology is finding wide applications in life science, most notably in magnetic resonance imaging, magnetic separation, and cancer diagnostics/treatment. Aiming for rapid cancer diagnosis and cancer sample preparation, our group has been developing a magneto-nano sensor chip and a magnetic sifter based on magnetic nanoparticles that allow rapid conversion of discrete biomolecule binding events into electrical signals. Furthermore, we are also developing novel magnetic nanoparticles to be used as multifunctional contrast agents for in-vivo imaging for living subjects.

The magneto-nano sensor chip will recognize and quantitate tumor markers in mouse and human serum samples with unprecedented sensitivity and specificity. These magneto-nano sensors function by exhibiting significant resistance changes (giant magnetoresistance or GMR effect) which are induced solely by external magnetic fields and are therefore insensitive to solution conditions such as buffers, pH or ionic strength. Biological sensing is accomplished by affinity labeling both the sensor surface and magnetic nanoparticles to simultaneously attach to distinct domains of specifically targeted biological molecules. The magneto-nano sensor then detects the attachment of the biomolecules through the magnetic field induced by the magnetic nanoparticles. The sensitivity of the magneto-nano sensor platform is shown to be below 1 pM for both proteins and oligos, and the platform presently has 64-channels to monitor many tumor markers simultaneously in a single test.

The magnetic sifter rapidly segregates biomolecules, based upon the tunable magnetic properties of the magnetic nanoparticles which bind them. We have successfully demonstrated a magnetic sifter for cancer sample preparation and performed proof-of-principle separation and sorting experiments.

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AP01

Fabrication of Carbonyl Iron Embedded Polycarbonate Composite Particles and Magnetorheological Characterization

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Magnetorheological (MR) fluids can change their state between a solid-like and a liquid-like state reversibly, rapidly and controllably with an aid of magnetic field. This state-changing process has great potential in designing active damper system, torque transducer or MR polishing equipment [1]. Carbonyl iron (CI) particles are considered as superior candidate for MR fluids due to their high saturation magnetization as well as their appropriate particle size. However, serious sedimentation problem due to large density mismatch between CI particles (7.91 g/cm^3) and medium oil (0.84 g/cm^3) restricts their further application on MR fluids. Therefore, many strategies were explored, among which polymer coating technology becomes prevalent owing to the favorable morphology and effective decrease in density by introducing organic polymer [2-3]. However, the morphology of coated polymer and the coating thickness were always influenced by selected grafting reagent, type of polymerization, reaction temperature and mole ratio of reactants.

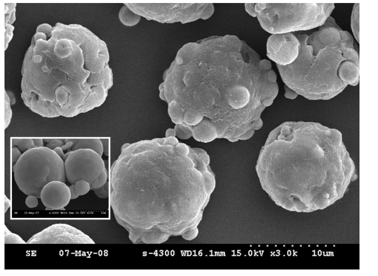

Fig. 1. SEM images of PC/CI and pure CI (inset) particles.

In this study, a more facile solvent casting method was adopted to prepare novel polycarbonate (PC) /CI particles. SEM images given in figure 1, compared with smooth surface of pure CI particles, shows that surface of the fabricated particles became considerably bumpy, in which CI particles were found to be randomly embedded not only within the inner but also the surface of spherical PC matrix. By this way, the direct contact of CI particles themselves was prevented, consequently leading to improved stability for the CI suspension with decreased density of 3.28 g/cm^3. An appropriate ratio of reagents were sought to contribute small size of PC/CI particles because large dimension of particles may have negative role in exhibiting superior MR performance. Finally, magnetic properties were investigated via VSM spectra together with MR characterization, in which flow curve (yield stress, shear viscosity) was analyzed as a function of magnetic field strength using a rotational rheometer.

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