Magnetoresponsive nanosystems with controlled morphology and surface functionalization

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The development of magnetic nanostructures for various applications requires control of the important characteristics of these materials: morphology and size, colloidal stability, surface properties and to ensure high magnetic moment. We report a comparative study of magnetic nanosystems with tunable size, morphology, magnetic and surface properties designed for applications in magnetic bioseparation, nanomedicine, security. Design of magnetoresponsive nanocomposites was achieved using different synthesis procedures that allow either controlled clustering of magnetic nanoparticles embedded into polymers or single-core magnetite nanoparticles coated with specific functionalized shells [1-3]. The coating of individual magnetite nanoparticles with various polymeric shells (polyesters, polydopamine) allows linking additional functions for attachment of biological entities like biotine, galactose. Multi-core magnetic particle systems coated with different polymers: (poly(N-isopropylacrylamide), polyacrylic acid, poly(3-acrylamidopropyl)-trimethylammonium chloride), poly(vinylpyrrolidone), polyethylene glycol or Pluronic 68 have been obtained by miniemulsion or solvothermal methods. TEM investigations show the close packing of magnetite nanoparticles into well-defined spherical microgel particles with sizes in the range 50-300 nm, while for core-shell nanostructures the magnetic core (mean diameter 10 – 30 nm) is covered with a polymeric shell. X-ray Photoelectron Spectroscopy investigation of surface chemical composition of the magnetic microgels and core-shell nanostructures confirms the nanocomposites formation and the attachment of specific functionalities. The magnetic nanocomposites show superparamagnetic behavior at room temperature and relatively high saturation magnetization values (50-90 emu/g). Our results show that optimizing the composition, structure and functional coatings of magnetic nanoparticle systems is a great promise for the design and reproducible manufacturing of single- and multi-core magnetoresponsive nanocomposites for specific applications.

References

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Figures

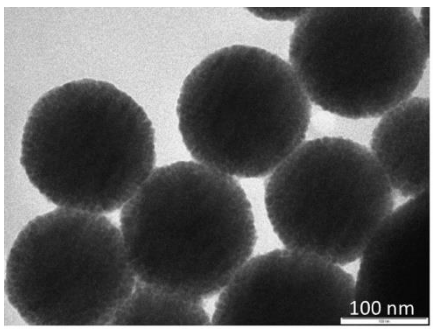

Figure 1. TEM image of magnetic clusters obtained by oil-in-water miniemulsion technique using highly stable ferrofluid.