Institute of Systems Biology and Ecology

Department of Biomagnetic Techniques

Characterization of magnetically responsive microcapsules

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The properties of magnetically responsive microcapsules depend on the characters of both non-magnetic and magnetic parts of the studied composite materials. The following parameters of magnetic moieties of microcapsules are important:

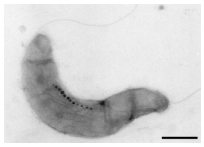
Magnetite (Fe_3O_4)
Maghemite (γ-Fe_2O_3)
Mixed iron oxides
Different types of ferrites
Nickel, cobalt, chromium dioxide

Chemical composition of magnetic materials

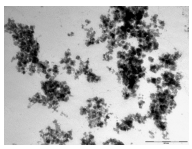
Magnetite, maghemite and mixed iron oxides exhibit low toxicity → ideal magnetic modifiers for the preparation of biocompatible magnetically responsive microcapsules

Biocompatibility

Multidomain (bulk)



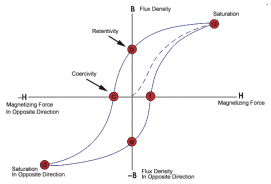
Single domain (magnetosomes from magnetotactic bacteria)



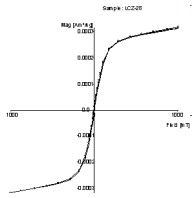
Superpara-magnetic (ferrofluids)

Size of magnetic particles influences magnetic behavior

Size of magnetic particles



Multi and single domain particles

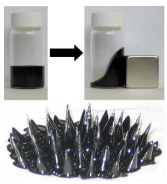


Superparamagnetic particles

Superparamagnetic nanoparticles exhibit no hysteresis

Magnetic behavior

Milled (powdered) magnetite (units of micrometers)



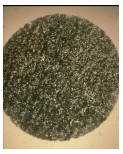
Magnetic fluids (~ 10 nm)

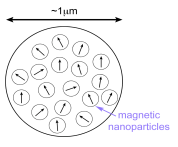
Examples of magnetic modifiers for particles preparation

Bangs Laboratories magnetic microspheres (~ 12 – 60 %)
Sera-Mag magnetic particles (~ 40 %)
Estapor magnetic particles (~ 10 – 65 %)
Dynabeads M-280 (17 %)
Magnetic agarose particles (Micromod) (45 – 50 %)
Chemagen magnetic particles (up to 60 %)
Perloza MG (Iontosorb) (30 %)

High magnetic material content enables rapid magnetic separation

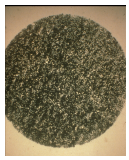
Amount of magnetic iron oxides in microparticles



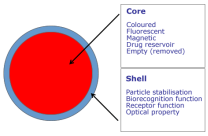


Homogeneously distributed superparamagnetic nano-particles in polymer matrix (Dynabeads) → the whole microparticles exhibit superparamagnetic behavior

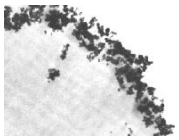
Mutual interaction of magnetic particles



Homogeneous distribution (Dynabeads)



Core-shell microparticles



Surface modified microparticles

Magnetic particles localization

Conclusions

The properties and behavior of magnetically responsive microcapsules can be substantially influenced by the chemical composition of the magnetic modifying component, its physical properties and the way of magnetic microcapsules preparation. Biocompatible microcapsules usually employ magnetic iron oxides nano- or microparticles as the magnetic modifier.