

Magnetic Sizing of Magnetic Nanoparticles

N. Buske, C. Gansau, T. Rheinländer and B. Kroll

Mediport Kardiotechnik GmbH, Wiesenweg 10, 12247 Berlin

Motivation:

Coated magnetic nanoparticles stably dispersed in polar or non polar fluids represent dispersions with superparamagnetic bulk properties (magnetic fluids) which were more and more used in science, technique, biology and medicine, i.e. for cell sorting, drug delivery and hyperthermia. Measurements of the hydrodynamic diameter of these core/shell nanoparticles by photon correlation spectroscopy (PCS) often show broad particle size distributions or particle size fractions that generally the scientific interpretation of MF properties hinders and an optimal application often limits. Therefore, novel methods for a sizing of core/shell-nanoparticles are an important goal for the future.

Materials/Methods:

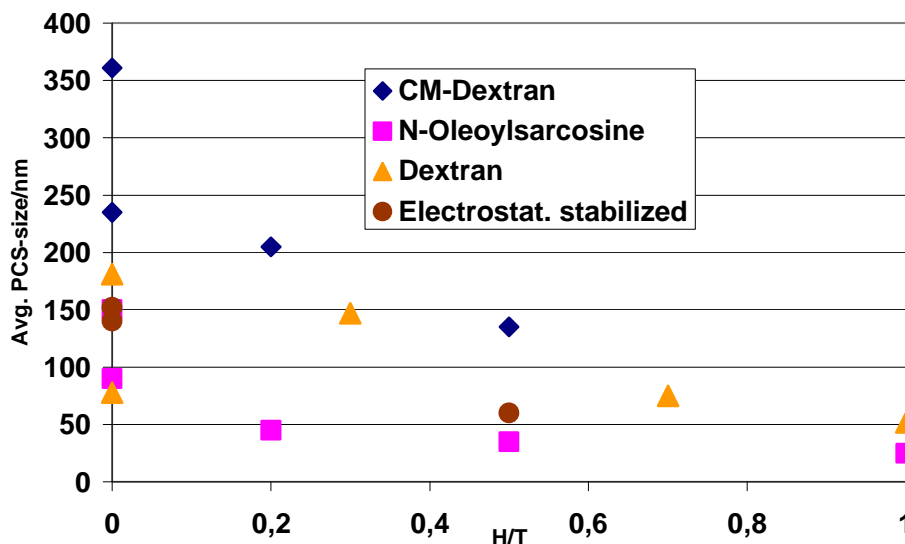
Magnetite nanoparticles prepared at similar conditions at Mediport Kardiotechnik were used. The particles were stable dispersed in

aqueous carriers at state of the art. The shell was on the one hand an electrochemical double layer of ions (surfactant free) and on the other hand, biocompatible polysaccharides (dextran, mw = 10 000, FLUKA, CM-dextran, mw. 15 000, FLUKA , N-oleoylsarcosine , SIGMA, [1]

The magnetic sizing in presence of an external magnetic field gradient was executed by a magnetic separator of GMW Associates (USA) combined with a bed of soft iron mm-spheres at using a similar procedure as described in [2].

Furthermore, magnetization curves of the MF's were taken to determine the saturation polarization of the MF / $I_s(MF)$ /, additionally the total iron concentration fraction φ and the Fe^{2+}/Fe^{3+} relation or the investigated magnetic fluids was experimentally determined by physico-chemical methods.

Fig. 2: Hydrodynamic unimodal PCS-size of coated magnetic nanoparticles as function of the magnetic field strength H



Results and Discussion:

First results are shown in Fig. 2:

Generally, by three particle size fractions per MF sample could be separated. Surprisingly, the electrostatically stabilized particles could be classified as well. As to expect [3] the particles were more or less aggregated (PCS-size: 130 ... 60nm).

As known the coated sterically stabilized particles are better stabilized towards aggregation.

Average medium PCS sizes from 200 to 17nm were observed. The last fraction could be consist of primary particles only. This is in overestimation with a size evaluation: they are designed by the magnetite core size between 5 and 15nm (by TEM) and the calculated layer thickness of 2 -3.5nm.

The values of the saturation polarization of the MF / $I_s(\text{MF})$ / and the volume fracture of the core was used for estimation of the saturation polarization of the particles ($I_s(p)$): $I_s(p) = \phi \times I_s(\text{MF})$. The values

kind of stabilizer, the age of the samples and the store conditions. Bulk material has a value of 600mT.

Conclusions:

Magnetic nanoparticles dispersed in aqueous carriers can be sorted by external magnetic field gradients by three or four fractions. The smallest fraction of sterically stabilized magnetite particles seems to be present the PCS-hydrodynamic size of primary (not aggregated) particles. The other fractions, including all fractions of electrostatically stabilized particles present PCS values of aggregated particles.

References:

- [1] N Buske; DE pat 198 52 152 (1997)
- [2] T. Rheinländer, R. Kötitz, W. Weitschies and W. Semmler; Colloid Polym Sci:278:259-63 (2000)
- [3] N Buske; Progr Colloid Polym Sci:95:175-180 (1994)