SAXS STUDIES OF Fe_3O_4/SiO_2 NANOPARTICLES FOR NANOSENSING

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Magnetic nanoparticles have been proposed for use as biomedical devices to a large extent for several years. Recently, nanotechnology has developed to a stage that makes it possible to produce, characterize and specifically tailor the functional properties of nanoparticles for various applications. In this lecture we will discuss magnetic nanoparticles before and after their surface modification The magnetic nanoparticles Fe_3O_4/SiO_2 consist of a magnetic core (Fe_3O_4) and SiO_2 shell. These nanoparticles can be manipulated using magnetic fields and therefore they possess attractive properties for biomedical [1,2] and magnetic resonance imaging [3] applications.

SAXS data were collected on the I7-11 beamline at Maxlab, Lund (Sweden) using the Mar 165 CCD detector. Nanoparticle and nanopartcle/DMPC samples were measured in water or 50 mM phosphate pH 6.7 buffer using synchrotron radiation (wavelength λ = 0.107 nm) at temperature 288 K. The sample-to-detector distance was 1.76 m, corresponding to the scattering vectors range of 0.05 to 3.42 nm^{-1}. All data sets were processed (normalized to the incident beam intensity, corrected for detector response and the scattering of the buffer was subtracted) using the computer programs BL 7-11 [4] and PRIMUS [5]. The pair distance distribution function p(r) was evaluated using GNOM [6].

The values of radii of gyration R_G characterizing the nanoparticles varied from 11.7 to 12 nm and D_{max} was about 34 nm. In mixtures of nanoparticles with biomembrane model systems based on DMPC, the scattering pattern characteristic for the lamellar phase of phospholipids was observed. The incorporation of nanoparticles has not induced phase transition in phospholipid systems.

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References

[1] M. Hilgendorff, M. Giersig, Magnetic nanoparticle superstructures, Eur. *J. Inorg. Chem.* **18** (2005) 3571–3583.

[2] Q.A. Pankhurst, N.K.T. Thanh, S.K. Jones, J. Dobson, "Progress in applications of magnetic nanoparticles in biomedicine", *J. Physics D-Appl. Phys.* **42** (2009) Art. N°. 224001.

[3] P.T. Narasimhan, R.E. Jacobs, "Microscopy in magnetic resonance imaging", *Ann. Rep. NMR Spectrosc.* **55** (2005) 259–297.

[4] M. Knaapila, C. Svensson, J. Barauskas, M. Zackrisson, S.S. Nielsen, K.N. Toft, B. Vestergaard, L. Arleth, U. Olsson, J.S. Pedersen, Y. Cerenius, "A new small-angle X-ray scattering set-up on the crystallography beamline I711 at MAX-lab", *J. Synchrotr. Radiat.* **16** (2009) 498–504.

[4] P.V. Konarev, V.V. Volkov, A.V. Sokolova, M.H.J. Koch, D.I. Svergun, "PRIMUS: a Windows PC-based system for small-angle scattering data analysis", *J. Appl. Crystallogr.* **36** (2003) 1277–1282.

[5] DI Svergun, "Determination of the regularization parameter in indirect-transform methods using perceptual criteria", *J. Appl. Crystallogr.* **25** (1992) 495–503.

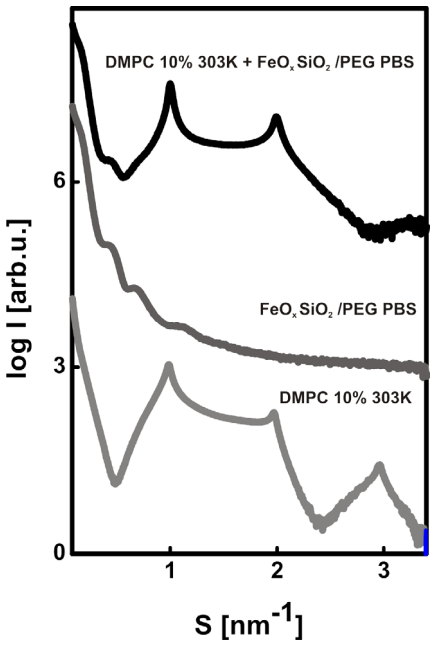

Figure 1. Small angle X-ray scattering curves of magenetic nanoparticles and their mixtures with DMPC.