OPTO-MAGNETIC DETECTION OF DIMER FORMATION OF SUPERPARAMAGNETIC FE_3O_4 NANOPARTICLES IN LIQUIDS. APPLICATION TO A MOLECULAR RECOGNITION TRANSDUCER.

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Fe_3O_4 superparamagnetic nanoparticles with a diameter below 10nm are of large interest for biosensors, medical diagnosis and NMR imaging techniques [1,2].

In the proposed biosensor biofunctionalized superparamagnetic nanoparticles [3] are to be used as ultra-sensitive molecular imaging nanoprobes for the detection of targeted biological objects. The detection mechanism is optical, employing a polarized light source which passes through the solution containing the nanoparticles. If dimers are present (which will be caused by molecular recognition) the application of a magnetic field orthogonal to the direction of light propagation will lead to a well defined axis of optical anisotropy in the solution, in turn leading to a difference in light intensity of the passed polarized light with changing applied magnetic field. The magnetic field can be pulsed or rotating.

Present work is concerned with preliminary studies employing superparamagnetic but not biofunctionalized Fe_3O_4 nanoparticles. The response signal for a rotating as well as pulsed magnetic field is analyzed, varying input parameters such as the strength and frequency of the magnetic field as well as the concentration of the nanoparticles in solution. Other parameters that can be used to detect molecular recognition are the phase lag between the magnetic field and the signal as well as the Brownian relaxation time of the particles when switching off the magnetic field. From the Brownian relaxation time, for example, one can extract the hydrodynamic diameter of the particle, knowing the viscosity of the solution [4]. Figure 1 shows the signal evolution for a pulsed magnetic field of 2.5 kA/m. An exponential fit to the relaxation signal yields the characteristic relaxation time from which the hydrodynamic diameter of the particles can be extracted (Figure 2).

References:

[1] E. Katz and I. Willner, Angew. Chem. Int. Ed., **43** (2004) 6042.
[2] Q.A. Pankhurst, J. Connolly, S.K. Jones and J. Dobson, J. Phys. D: Appl. Phys., **36** (2003) R167
[3] J.M. de la Fuente, S. Penadés, Biochimica et Biophysica Acta **1760** (2006), 636
[4] E. Romanus, C. Groß, G. Glöckl, P. Weber, W. Weitschies, J. Magn. Magn. Mater., **252** (2002) 384

Figures:

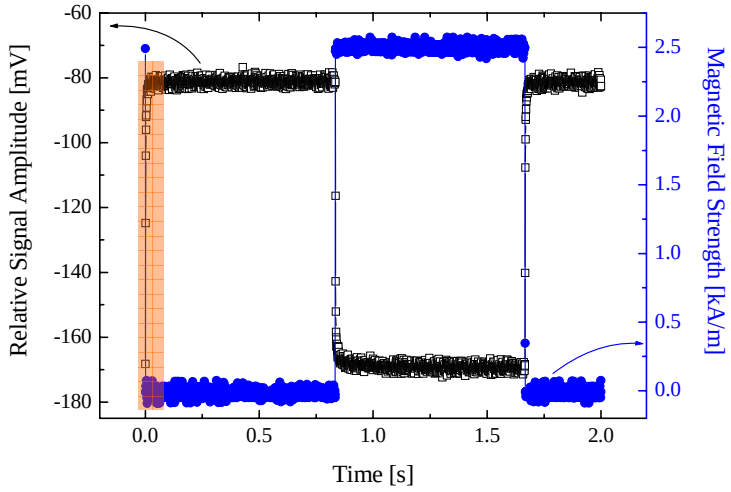

Figure 1 Signal evolution for a pulsed magnetic field of 2.5 kA/m. When the magnetic field is switched off the particles relax (marked region).

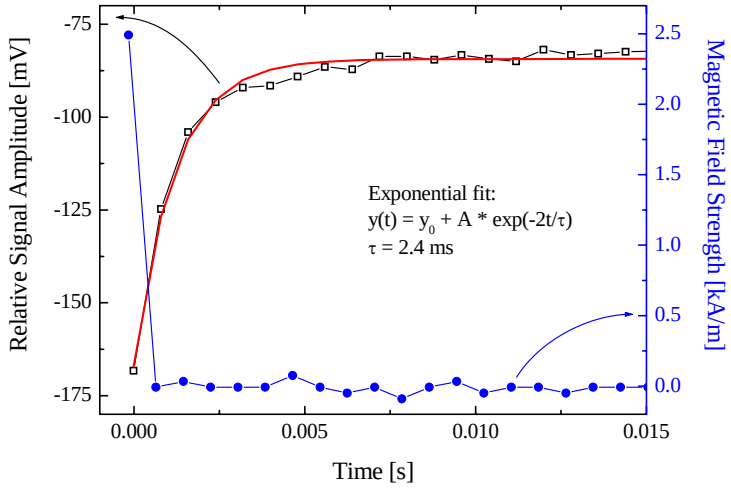

Figure 2 Exponential fit to the relaxation signal yields the characteristic relaxation time of the nanoparticles which can be translated into their hydrodynamic radius.