Proceedings of the 5th International Conference on Nanotechnology: Fundamentals and Applications
Prague, Czech Republic, August 11-13, 2014
Paper No. 245

EPR Measurements of Nanoparticles Diffusion in a Magnetic Field

Bernadeta Dobosz, Ryszard Krzyminiewski, Tomasz Kubiak
Medical Physics Division, Faculty of Physics, Adam Mickiewicz University
Umultowska 85, 61-614 Poznań, Poland
benia@amu.edu.pl, rku@amu.edu.pl, tomekfizyk@wp.pl

Magdalena Hałupka-Bryl
The NanoBioMedical Centre
Umultowska 85, Poznań, Poland
magdalenahalupka@op.pl

Joanna Kurczewska, Grzegorz Schroeder
Faculty of Chemistry, Adam Mickiewicz University
Umultowska 89B, 61-614 Poznań, Poland
asiaw@amu.edu.pl, schroede@amu.edu.pl

Extended Abstract

Superparamagnetic behaviour, low toxicity, chemical stability and biodegradability are the properties which cause that magnetite nanoparticles could have many biomedical applications. One of them is magnetically controlled transport of anti-cancer drugs. Using a magnetic field it is possible to deliver magnetite nanoparticle to desired location of the body where the anti-cancer drug will be released. From this reason it is important to study the diffusion of such nanoparticles before they are used in medical treatment.

Two types of nanoparticles were used in the experiment. One of them were magnetic nanoparticles modified with original surface modification agent - PEG-derivative (poly(ethylene glycol)-*block*-poly(4-vinylbenzylphosphonate)) and the anticancer drug. Iron oxide nanoparticles were synthesized by alkali co-precipitation of iron salts followed by coating with copolymer (PEG-PIONs). An anticancer drug doxorubicin (DOX), which clinical use is associated with cardiotoxicity, was loaded onto PEG-PIONs (PEG-PIONs/DOX). In second type of samples instead of doxorubicin the spin label TEMPO (2,2,6,6-tetramethyl-1-piperidinyloxy), which is a good marker in electron paramagnetic resonance (EPR) measurements, was attached to polymer-coated Fe_3O_4 nanoparticles. The nanoparticles were diluted in water. The diffusion was also checked in bovine serum, to which the nanoparticles were added.

The EPR measurements were performed using X-band (9,4 GHz) Bruker EPR/ENDOR EMX-10 spectrometer. The measurements were carried out at 240K temperature. The samples were placed in a magnetic field 350 mT for 5 and 15 minutes. After this time they were placed in the resonator and frozen without any additional magnetic field to appropriate temperature. The position of each sample in the resonator was changed in a controlled manner every 0.5 mm and 10 layers were measured for each sample.

Typical EPR spectrum for magnetite core was recorded with g-factor equals 2.042 and 67 mT line width at room temperature. For sample with TEMPO both wide line from magnetite and typical spectrum from TEMPO was obtained (Figure 1). For each layer the concentration of magnetite was calculated to check out the diffusion process related to previous placing sample in a magnetic field (Figure 2). The

comparison between the nature of the diffusion for nanoparticle sample as well as for the same sample added to serum bovine was made.

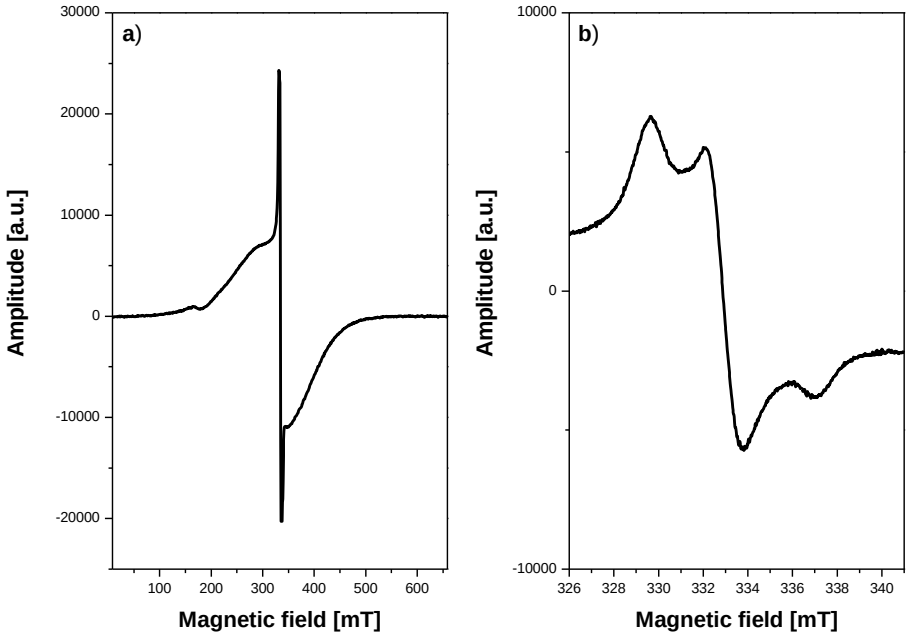

Fig. 1. Exemplary EPR spectra of magnetite nanoparticles with TEMPO at wide (a) and narrow (b) magnetic field range recorded at 150K.

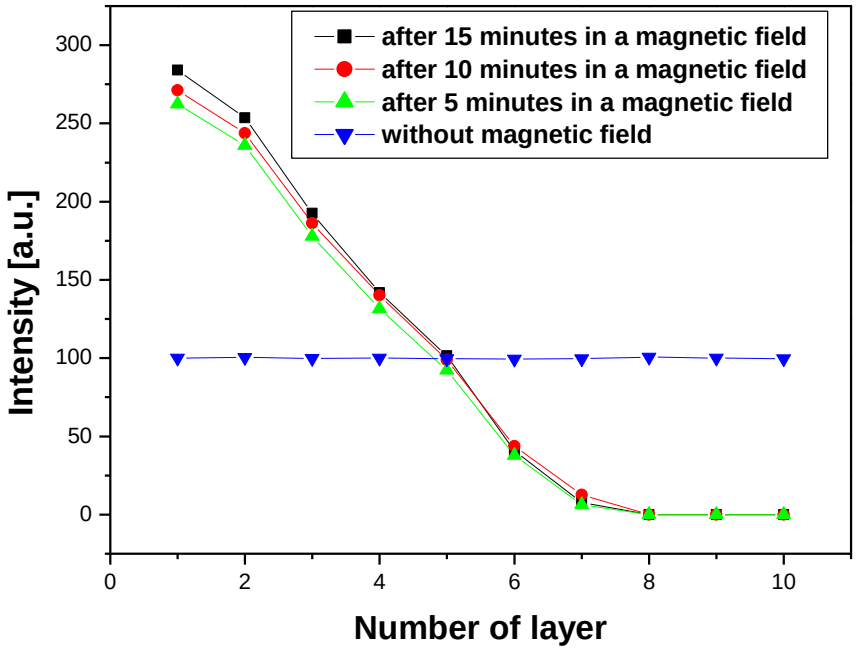

Fig. 2. Changes of nanoparticles concentration in particular layers caused by keeping them in a magnetic field.