MA 7: Magnetic Particles in Biomedical Diagnostics and Therapy (jointly with BP,CPP,ST)

Time: Monday 9:30–11:15 Location: H22

Invited Talk MA 7.1 Mon 9:30 H22

Time-of-Flight Magnetic Flow Cytometry — •Michael Helou[1,4], Mathias Reisbeck[1], Lukas Richter[1], Jacobus Bosch[2], Roland Stauber[3], Eckhard Quandt[4], and Oliver Hayden[1] — [1]Siemens AG, Corporate Technology, 91058 Erlangen, Germany — [2]Department of Medicine 5, Hematology and Medical Oncology, University Hospital Erlangen, 91054 Erlangen, Germany — [3]Molecular and Cellular Oncology/Mainz Screening Center (MSC), Medical University Mainz, 55101 Mainz, Germany — [4]Institute for Materials Science-Inorganic Functional Materials, Christian-Albrechts-Universität zu Kiel, 24143 Kiel, Germany

Flow cytometry - the gold standard for clinical single cell analysis - requires a point-of-care solution for decentralized applications. Here, we show a novel approach towards a time-of-flight magnetic flow cytometry using superparamagnetic iron-oxide nanoparticles (SPION) labeled cells. Within a microfluidic channel we are able to perform specific cell enrichment and cell focusing by magnetophoresis as well as single cell detection with integrated GMR sensors in a single step. We even take advantage of the magnetophoresis for an in-situ elimination of the background from non-bound markers. In addition, time-of-flight measurements of the labeled cells allow us to derive cell diameter information. Proof-of-concept of our magnetic flow cytometer is demonstrated with SPION labeled tumor cells spiked in stabilized whole blood.

15 min. break

MA 7.2 Mon 10:15 H22

Effect of ferritin on spin of NV centre in diamond — •Anna Ermakova[1], Goutam Pramanik[2], Jianming Cai[3], Boris Naydenov[1], Liam McGuinness[1], Fedor Jelezko[1], Tanja Weil[2], and Martin Plenio[3] — [1]Institute of Quantum Optics, University Ulm — [2]Institute of Organic Chemistry III, University Ulm — [3]Institute of Theoretical Physics, University Ulm

The nitrogen-vacancy (NV) centre is a stable optical centre in diamond, which also has application in sensing. Spin of NV centre has high sensitivity of the magnetic field and can be use like a magnetic detector with nanoscale resolution [1,2]. Moreover, diamond is a biocompatible material and nanodiamonds (NDs) are known to be non-toxic for a variety of cells [3]. It*s mean that spin properties of nitrogen-vacancy centre in ND can find wide application in medicine diagnostic. In this work we used NDs with 30 nm in size, which were attached with ferritin. Ferritin is hollow protein shells that can store 2500-4000 iron atoms and is 8 nm in diameter. It is a important component of a human blood. Ferritin saves human from toxic free iron atoms and keeps iron to produce haemoglobin in further. One ND has around 10 ferritin molecules. Here, we present the change of relaxation times of spin of NV centre in NDs with attached ferritin. We observed that T1 and T2 of NDs with ferritin molecules are less by five times than of free NDs. We also show the theoretical model which explains these changes. 1) Balasubramanian G. et al. Nature 455 (2008),648-651 2) J.M.Taylor, P.Capellaro et al., Nature Physics,4,810*816 (2008) 3) A.M.Schrand et al., J Phys Chem B, vol.111,No.1(2007),2-7

MA 7.3 Mon 10:30 H22

Realization of homogeneous bioassays using magnetic nanoparticles in time-varying magnetic fields — •Frank Ludwig, Thilo Wawrzik, Jan Dieckhoff, and Meinhard Schilling — TU Braunschweig, Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik, Hans-Sommer-Str. 66, D-38106 Braunschweig

Homogeneous bioassays utilizing functionalized magnetic nanoparticles (MNP) are based on the MNP's dynamics in time-varying magnetic fields which differs for bound and unbound markers. For this the dynamics of unbound markers must be dominated by the Brownian mechanism whereas bound ones relax either via the Brownian mechanism with an increased time constant or via the Néel mechanism. In our group, the following principal approaches for the realization of homogeneous bioassays with MNP are pursued: With our fluxgate magnetorelaxometry (MRX) setup, the dynamics is studied in the time domain and time constants between about 400 μs and a few s are accessible. With our ac susceptibility (ACS) systems, the dynamics is studied in the frequency domain for excitation field frequencies between a few tens of Hz and 1 MHz. Similarly to the ACS technique, the MNP can be exposed to a rotating magnetic field, and the phase lag between field and sample moment is studied. In magnetic particle spectroscopy (MPS), the harmonic spectrum of the MNP sample is measured in a large sinusoidal magnetic field. Examples for the realization of homogeneous binding experiments utilizing the different techniques will be presented. This work was supported by the FP 7 project NMP-2010-246479 and by the DFG via SFB 578.

MA 7.4 Mon 10:45 H22

Direct Protein Detection in the Sample Solution by Monitoring Rotational Dynamics of Nickel Nanorods — •Stefan Schrittwieser[1], Frank Ludwig[2], Jan Dieckhoff[2], Andreas Tschoepe[3], Annegret Guenther[3], Michael Richter[1], Andreas Huetten[4], Hubert Brueckl[1], and Joerg Schotter[1] — [1]AIT Austrian Institute of Technology, Vienna, Austria — [2]TU Braunschweig, Braunschweig, Germany — [3]Universitaet des Saarlandes, Saarbruecken, Germany — [4]Bielefeld University, Bielefeld, Germany

We present experiments that demonstrate the feasibility of a recently introduced homogeneous immunodiagnostic approach to directly detect analyte binding by optical observation of the hydrodynamic properties of magnetically rotated nanorods ("PlasMag"). Specifically, we show that the phase lag of the long axis of nickel nanorods (magnetic core parameters: length 182 nm, diameter 26 nm) with respect to externally applied rotating magnetic fields significantly increases on the adhesion of bovine serum albumin (BSA) protein to their surfaces. To validate these results, we independently determine the amount of bound protein molecules by analysis of the electrophoretic mobility of the nanorods, which gives a protein surface density of 5.8 femtomol / mm^2.

Acknowledgements: The research leading to these results has received funding from the European Community's 7th Framework Programme under grant agreement no 246479 (NAMDIATREAM).

MA 7.5 Mon 11:00 H22

Bioassay based on the response of magnetic nanoparticles to rotating magnetic fields — •Jan Dieckhoff, Meinhard Schilling, and Frank Ludwig — Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik, TU Braunschweig, Hans-Sommer-Str. 66, 38106 Braunschweig

The possibility to directly affect the dynamics of magnetic nanoparticles in a magnetic field via the binding of target molecules to the particles functionalized surfaces has led to the realization of different homogeneous bioassays. Besides the frequently applied alternating magnetic field, the rotating magnetic field offers an interesting alternative for the manipulation of the magnetic nanoparticles. In the rotating magnetic field the nanoparticles experience a rotational motion according to the rotating field frequency and amplitude. Due to drag forces and thermal energy, a phase lag between the rotating field and the nanoparticles magnetization occurs which depends strongly on the particles hydrodynamic size. Analyzing this value, a robust and precise homogeneous bioassay can be realized, that offers a higher sensitivity compared to the alternating magnetic field mode. In this presentation, simulation and measurement results of binding experiments in an alternating and rotating magnetic field are presented and analyzed. Moreover, challenges regarding the magnetic nanoparticles and possible approaches are discussed. This work was supported by the European Commission Framework Programme 7 under the NAMDIATREAM project (NMP-2010-246479).