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Magnetic particles as labeling material for advanced biological applications

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Abstract – *Magnetic particles (MPs) attract an increased attention as a material for advanced biological and medical applications, including immunomagnetic separation, drug delivery, magnetic resonance imaging, and hyperthermia. Control over the particle properties and their coating strongly influences the interactions with biological materials. This talk will give an overview on our results on nanomagnetic and physicochemical surface properties of synthesized nanoparticles as well as on forces and interactions that are important for their use indifferent biological applications. Furthermore, the use of MPs will be demonstrated for the development of an integrated magnetic lab on chip to separate, genetically purify and identify tumor cells from blood.*

For certain applications, such as magnetic resonance imaging (MRI) or magnetothermia, monodisperse MPs with a high magnetic moment are desired. As most commercially available particles lack these properties, we have chosen to synthesize iron oxide (Fe_xO_y) and doped (Co^{2+}, Mn^{2+}) iron oxide MPs (~10 nm) by the thermal and hydrothermal decomposition method. Both methods rely on the LaMer model to ensure small, spherical and narrow size distributed magnetic particles. After synthesis the particles require a surface coating modification for their use in biological samples. This has been achieved using a ligand addition of phospholipids or an exchange with dimercapto-succinic acid (DMSA). Their use as MRI contrast agent will be evaluated.

Advanced lab-on-a-chip systems should combine the sample preparation and final detection on a single platform. Especially the integration of the sample preparation remains challenging and often off-chip traditional benchtop methods are still preferred. In this presentation, the use of superparamagnetic beads are proposed to facilitate the on-chip separation of cells, purification of DNA materials, and downstream target detection using giant magnetoresistive (GMR) sensors [1,2,3]. We demonstrate that magnetically labeled circulating tumour cells can be separated from other cells and from magnetic particles using magnetophoresis via on-chip traveling fields. We also demonstrate that beads coated with complementary DNA capture probes can be used to perform specific purification of DNA fragments that can afterwards be attracted towards a GMR sensor for their specific and sensitive detection.

In summary, we will show how the use of these magnetic beads both in *in vivo* and *in vitro* diagnostic systems may greatly impact clinical diagnostics, theranostics and therapy follow up.

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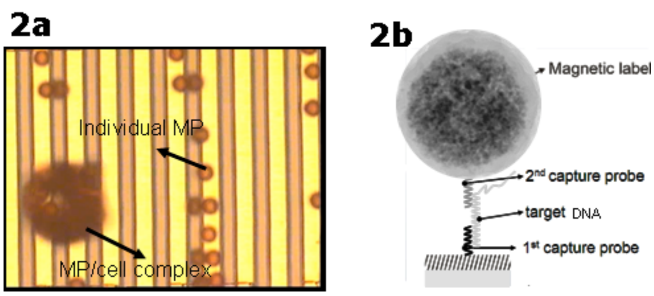

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