Budapest University of Technology and Economics
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# ENZYME COATED MAGNETIC NANOPARTICLES FOR USE IN CONTINUOUS FLOW MICROFLUIDIC DEVICES

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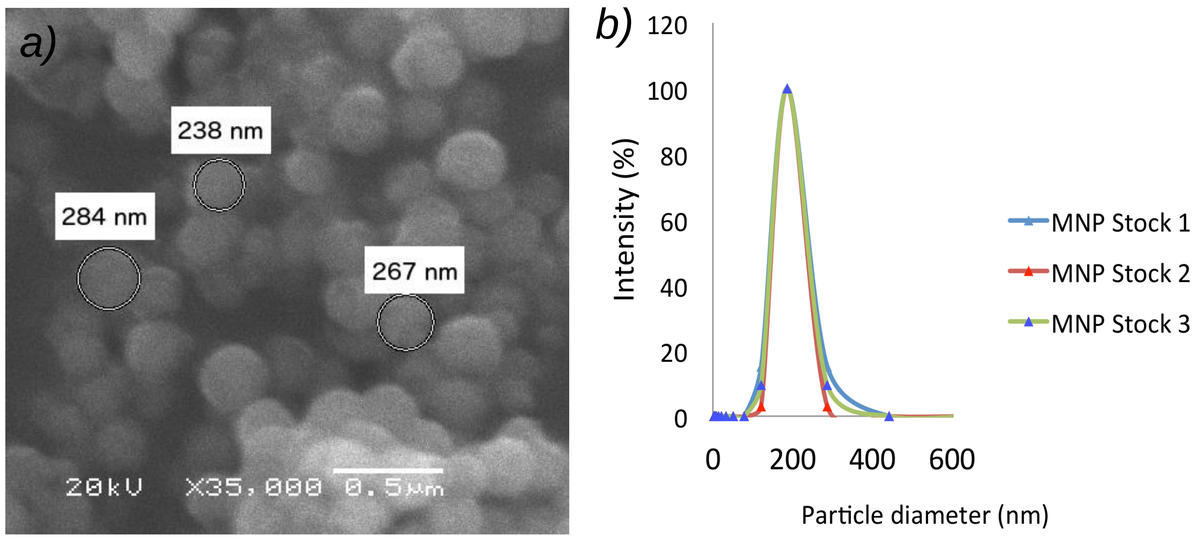
## Background and motivation

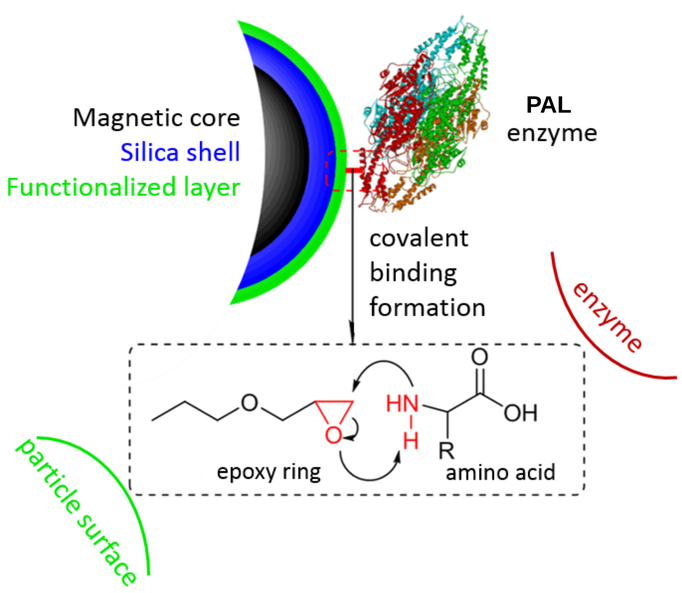
Magnetic nanoparticles (MNPs) are widely used as bio molecule carriers providing higher reactive area and low diffusion limits, specific modifications enabling convenient handling within chip sized fluidic structures. Our infrastructure for the production of tailor made MNPs enables to optimize the particles for the use in a LoC platform. The novel platform incorporates micro-sized magnetic reaction cells capable of anchoring protein-coated MNPs addressable and selectively. Such platform allows the design of highly flexible and "programmable" execution of multienzyme processes for biocatalytic or diagnostic purposes.

## Nanoparticle production and biofunctionalization

Among various syntheses known for the preparation of MNPs, the solvothermal method was used and further developed resulted in an easy to handle, robust way to prepare monodisperse *magnetite* ($Fe_3O_4$) spheres in well tunable size range.




*a) SEM image and b) DLS size distribution of the produced magnetic nanoparticles (mean size of d=250 nm)*

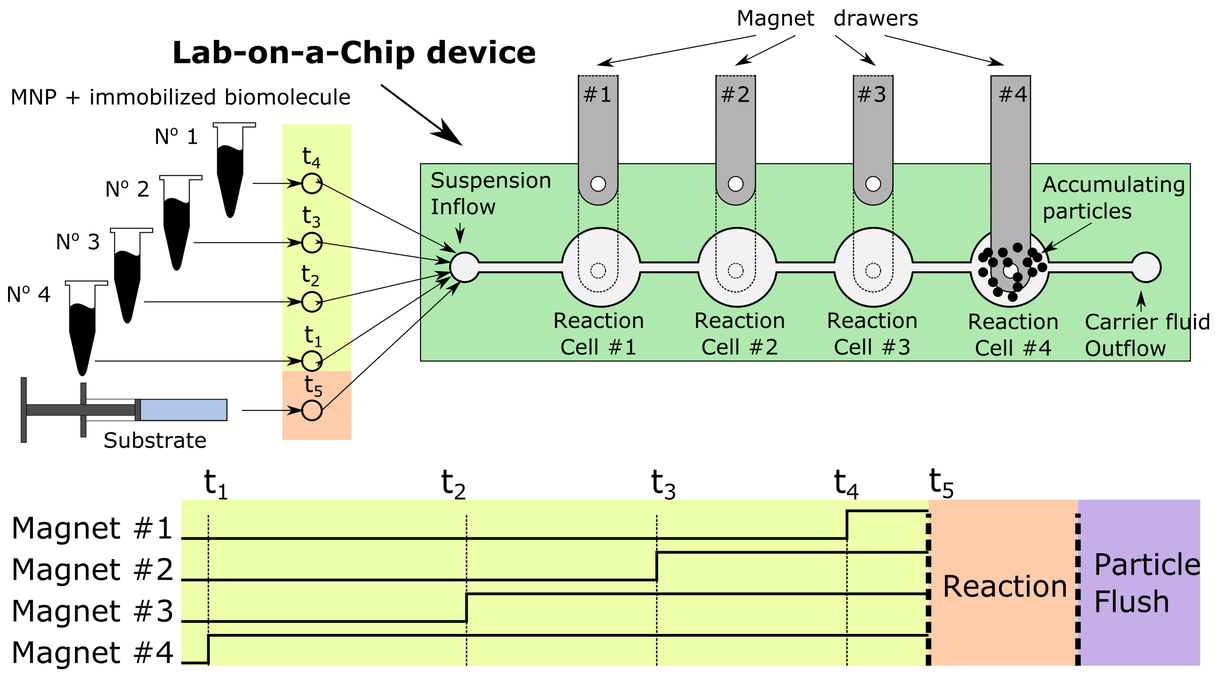



*Immobilization mechanism of (PAL) enzyme on to epoxy functionalized magnetic nanoparticles*

Chemical function groups were created aiming the formation of covalent binding between the magnetic nanoparticles and the enzyme molecules. Firstly, a stable and biocompatible silica shell was built around the naked iron-oxide magnetic particles. Secondly, epoxy rings were attached to the surface. Stable covalent binding is easily formed between the amino acid chains of the enzyme and the epoxy rings.

## MNP micro reactor platform

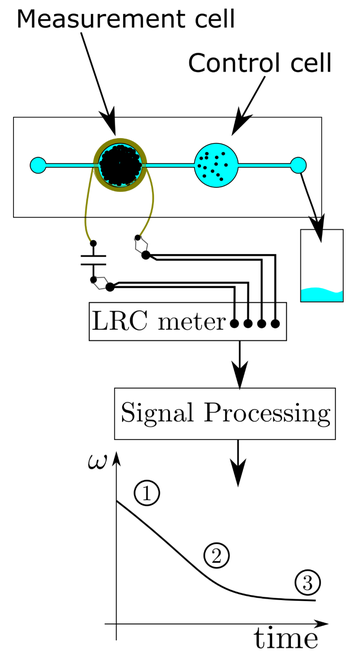
LoC device was constructed on glass-PDMS technology. MNPs can be selectively anchored in reaction cells of 1 µl using permanent magnets located under the device. Different cell configurations enable various applications in biocatalysed synthesis or bioanalysis.




*Timing diagram of the magnet activation in the cells*

*Schematic operation of the MNP micro reactor platform with four different biomolecule loading*

*In-situ measurement of MNP quantity of the cells based on the resonance frequency measurement of an RLC circuit using an integrated flat coil as sensor, placed under the cell. 180 µg of MNP (d=250 nm) can be trapped in each chamber with excellent reproducibility*




*a) Biocatalysed reaction of L-Phenylalanine by PAL enzyme, compared in a shaked vial vs. in LoC device. Biocatalytic activity was found to be more than four times higher in the LoC case*
*b) filling up sequence of a chamber with MNP on 1 minute time scale c) four reactor type chip with fully filled chambers by 250 nm MNPs*