Advanced Magnetic nano-particles deliver smart Processes and Products for Life

M. Franzreb [1], M. Cerff [2], I. Fischer [1], J. Lindner [3], T. Müller [1], A. Scholz [2]
[1] Karlsruhe Institute of Technology, Institute for Functional Interfaces; [2] Karlsruhe Institute of Technology, Institute of Bioprocess Engineering; [3] Karlsruhe Institute of Technology, Institute of Mechanical Process Engineering and Mechanics
Contact: Mr Koen Denoo, kdenoo@solae.com, http://nanobiomag.mvm.uni-karlsruhe.de/

Focus

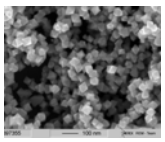
Functional magnetic (nano)particle composites have the potential to enhance the performance and economics of bioseparation processes, because of their extremely high surface areas, rapid binding kinetics, and unique physical and chemical properties. The two major barriers to implement the industrial use of magnetic (nano)particle composites are the safe and effective large-scale manufacturing of appropriately functionalized (super)paramagnetic particles, and the lack of large-scale process technology to separate these particles from the production streams. The goal of the MagPro²Life project is to address these barriers and demonstrate the use of functional magnetic (nano)particle separation at pilot-scale for selected feed, food, and biopharma products.

Particle synthesis

Functionalization - Analytics

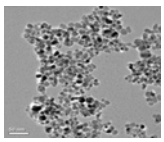
In this part the main focus is to develop a set of inexpensive (super)paramagnetic nano-(composite) materials that have enhanced physical and chemical properties. A large variety of synthesis routes will be established.

Continuous Suspension Synthesis

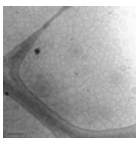


Solution / Spray-Process

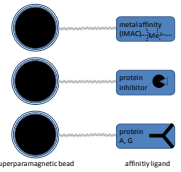
Laser Pyrolysis/ Precipitation



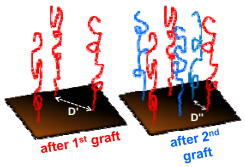
Rotating Membrane Pore Extrusion



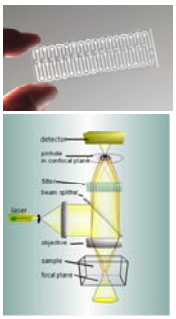
In the next step magnetic matrices will be coated and biochemically functionalized in many ways to obtain powerful nano- and micromaterials with unique adsorptive properties. Current techniques will be developed further to analyze molecular and particle interaction as well as binding kinetics at the µ-scale.



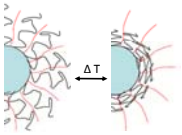
Affinity ligands



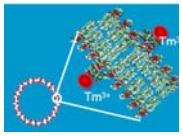
Bifunctional grafted ligands



Advanced analytical tools: Accurate stochastic fluorescence spectroscopy (ASFS)



Thermoresponsive materials

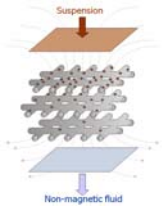


Functionalized vesicles

Process development

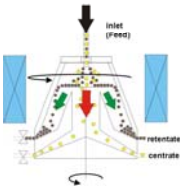
Particle handling

High Gradient Magnetic Filtration



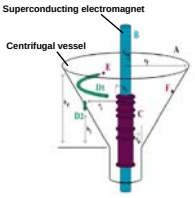
Particles attach to a filter through magnetic attraction forces

Magnetic Field Enhanced Centrifugation



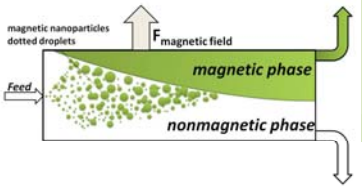
A magnetic filter is cleaned continuously by centrifugation.

Magnetic Classification



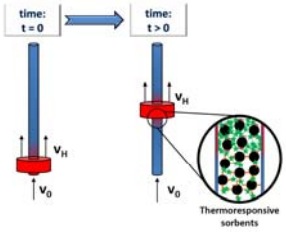
Magnetic and centrifugal forces are counter-directed for classification

Continuous Magnetic Extraction



Nanoparticles are continuously extracted in an aqueous two-phase system augmented by an external magnetic field

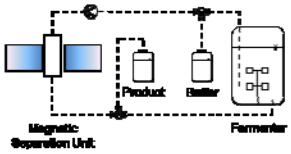
Travelling Heating Zones Reactor



Combination of a novel separation device with thermoresponsive sorbents

Applications to be tested

In-situ product removal of enzymes applied in Feed during fermentation



- Fermentation intensification via the integration of multi *in situ* magnetic separation steps
- Prevention of product degradation by e.g. capturing proteases

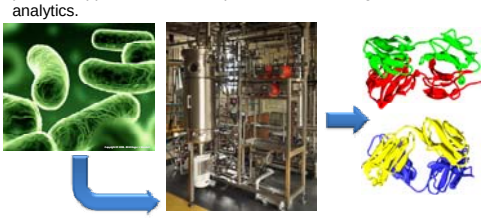
Recovery of nutraceutical biomolecules from large-scale natural Food streams

- Exploitation of high value functional food proteins from soy process streams with specific attributes for health, well-being and/or prevention of diseases

Demonstration of the validity of magnetic separation technology for high throughput food industries

Direct capture of high-value Biopharma proteins from crude feed streams

- One step purification of novel antibody fragments (Fabs) with potential applications as therapeutics, medical diagnostics and analytics.



Recombinant *E. coli* **Fermentation** **Fabs**

- Systematic benchmarking of magnetic nanoparticle-based bioseparation processes against established DSP approaches, e.g. S/L separation followed by chromatography

Project partners

- Solae
- Karlsruhe Institute of Technology
- University Birmingham
- Technische Universität Bergakademie Freiberg
- National Institute for Laser, Plasma and Radiation Physics
- Merck KG
- Universidad de Salamanca
- fluIT Biosystems GmbH
- University College Dublin
- KMPT AG
- Swiss Federal Institute of Technology
- Technical University of Denmark
- Romanian Academy- Timisoara Branch
- Bühler AG
- NIIMT – Cluj Napoca