Autonomous optimisation of surface functionalisation of magnetic particles for nucleic acid purification

Job type: Master thesis

Institute: Institute for Functional Interfaces (IFG)

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Background:

The purification of nucleic acids is a critical step in molecular biological research, diagnostics and increasingly also therapy, which forms the basis for numerous applications such as genome sequencing, PCR, and the production of gene therapeutics and vaccines, among others. Magnetic particles are playing an increasingly important role here, as they offer a fast, efficient and scalable way of isolating nucleic acids from complex biological samples. As no complex equipment is required, magnetic particle-based methods are particularly suitable for automated high-throughput processes. However, the surfaces of these particles must be specifically functionalised to enable high selectivity and capacity for binding nucleic acids. The optimisation of this surface functionalisation is crucial in order to maximise the efficiency and purity achieved during separation. Many different functionalisations can be considered for this purpose, which can also be applied in different ratios, making it a difficult to predict, multivariate optimisation problem. To solve this problem, it makes sense to automate functionalisation processes and establish an autonomous, i.e. self-learning, system based on the generated data using machine learning (ML) and optimisation algorithms, which iteratively improves the manufactured particles.

Objectives/work packages:

The aim of this work is to establish such an autonomous system to optimise the functionalisation of particles for the purification of nucleic acids.

The work packages to be carried out are as follows:

- Literature study on nucleic acid purification, magnetic particles, functionalisation and optimisation using machine learning

- Design of SOPs for surface functionalisation and implementation in the automated system

- Generation of workflows for automated data storage and evaluation as well as for parameter optimisation

- Demonstration of highly accelerated material development of particles with high selectivity and binding capacity, as well as comparison with commercial particles

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