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Prototyping a point-of-care system for extracellular vesicle detection using magnetics.

The use of extracellular vesicle (EV) detection strategies for highly sensitive point-of-care systems and liquid biopsy has shown great potential to gain further insights into human disease diagnostics. One major challenge of EV-based diagnostics is the small scale of the carrier, limiting light-based detection and analysis methods. This limitation further results in low sample throughput and low specificity regarding EV-based detection of disease markers. One way to overcome these challenges is to combine EV extraction methods with magnetic trapping systems such as magnetic micropores, magnetic gradient devices, or localized magnetic traps. This project aims to develop a rapid in situ on-chip EV size profiling assay using the concept of magnetic traps. In this project the MONT Empower Scholar will prototype the design of an EV trapping assay on chip using computer-aided design (CAD) software with finite-element simulations (FEM, COMSOL Multiphysics). After the design step, the scholar will learn cleanroom-based fabrication of magnetic trapping features that can be utilized as a proof of concept. This project involves learning how to fabricate small magnetic features, how to capture even smaller lipid structures from conditioned cell culture fluids. Throughout the project, the student will be exposed to cutting-edge methods for extracellular vesicle-based detection methods, which are used to detect neurodegenerative disease markers. If a successful prototype emerges from the student work, the chip can be used to detect, sort, and analyze EVs carrying hallmarks of Alzheimer's and other neurodegenerative diseases. Furthermore, the student will be embedded in a vibrant lab dynamic in the Kunze Neuroengineering Lab, consisting of several graduate and undergraduate students. Besides a unique interest in micro- and nanofabrication technology, strong communication skills, weekly participation in lab meetings, as well as team-working attitudes, are expected. At the end of the project, the student will have gone through the design approach for point-of-care systems using micro- and nanotechnology in the sector of neurodegenerative diseases. It is recommended to combine this project with taking the BioMEMS course in the ECE Department during the junior year. This project can be further developed into an ECE CAPSTONE project. The student may also use a successful prototype as a starting point for entrepreneurship in the point-of-care or human disease diagnostics sector.

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