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Exosomes are membrane vesicles with sizes ranging from 30 to 200 nm secreted by almost all mammalian cells. They play a pivotal role in cell-to-cell communication and in transferring various biomolecules such as proteins, microRNAs, and DNAs. Research on exosomes is mainly focused on exploiting their potential as biomarkers for disease diagnosis and their possible use in therapeutic applications such as drug delivery and tissue regeneration. As a result, their involvement in various physiological and pathological processes, including immune response and cancer progression, has been intensively studied in recent years.[1]

The extraction of exosomes from biological materials results in polydisperse suspensions containing the desired nanoparticles as well as various cells and debris. For biomedical purposes, it is necessary to carry out their separation. However, these vesicles are susceptible to mechanical damage, and current conventional separation methods, such as ultracentrifugation and filtration, risk sample degradation complicating the practical use of exosomes. Therefore, research in this area has focused on non-destructive methods as is, for example, the separation method based on microfluidic viscoelastic flow. In microfluidic devices, viscoelastic fluids are used to create controlled flow patterns that can selectively separate particles of different sizes by experiencing both viscous drag and elastic lift forces. The balance between these forces can cause specific particle migration. By carefully designing the flow conditions (flow rate, channel geometry) and fluid properties (viscosity), it is possible to exploit this migration behavior to separate exosomes from larger contaminants. Smaller particles like exosomes will experience less elastic lift and migrate closer to the channel walls, while larger particles are pushed toward the channel center.[2] These microfluidic viscoelastic flow-based separation methods offer several advantages, including low sample volume requirements, high-throughput processing, minimal sample dilution, and reduced risk of sample degradation. However, challenges remain in optimizing fluid

properties and device designs for specific applications and ensuring the scalability and reproducibility of these techniques.

The research on exosome separation from polydisperse suspensions, where particle diameters vary in the range of 100-1000 nm, was carried out experimentally and with the help of numerical simulations. The work included fine-tuning the experimental methodology, writing an in-house code for exosome tracking based on a one-way approach, and performing a parametric study to investigate the separation potential of the microdevice as a function of channel geometry, flow rate, and viscosity. Preliminary results show that viscoelastic microfluidics can be used as an alternative to conventional exosome separation techniques.

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