MONASH University

MONASH INNOVATION

ULTRASOUND-ACTIVATED NANOPARTICLE FILTRATION AND PURIFICATION

A novel method of applying ultrasound waves to trap nanoparticles in a continuous flow without any prior functionalisation or preparation. The method is contact-free and label-free. It has been tested on nanoparticles with sizes down to 100nm, with 97% capturing efficiency. It is ideal for separation, filtration and/or enrichment processes.

- **High capturing efficiency (97%)**
- **Can be integrated into continuous systems**
- **Fast and high enrichment returns**
- **Bio-compatible and label-free**

THE CHALLENGE

In the field of biological and biomedical studies there is a significant interest in capturing and extracting high concentrations of extracellular vesicles (EVs) ranging from 50 – 1000 nm. For EVs to be used as biomarkers they need to be separated and segregated into their particular types or for the purpose of synthesis of medicine, a very quick and clean method of collection and enrichment is necessary.

The conventional methods currently being used are ***time consuming***, ***laborious*** and generally ***damaging*** to the bioparticles and/or only available for small number of samples; they may also be polluting for chemical bonds that capture nanoparticles. In many other applications such as water filtration, precious metal harvesting and nanoparticle synthesis, the demand is for fast, clean and high-performance separation of nanoparticles.

THE TECHNOLOGY

In this novel method a packed-bed of microscale particles or pillars is mechanically excited by the use of ultrasound surface acoustic waves (SAW). The activation of the packed bed of microbeads generates attractive inter-particle forces that collect the passing submicron-sized particles, a Sound Wave Activated Nano-Sieve (SWANS). As long as the ultrasound activation is held, the collection of nanoparticles continues.

Figure 1. Schematic setup of SWANS integrating surface acoustic waves and the microfluidic channel

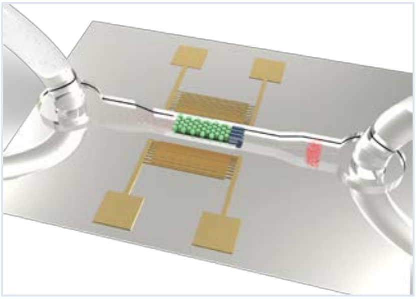


Figure 2. Next step of production: Prototype of up-scaled system that can handle larger volumes

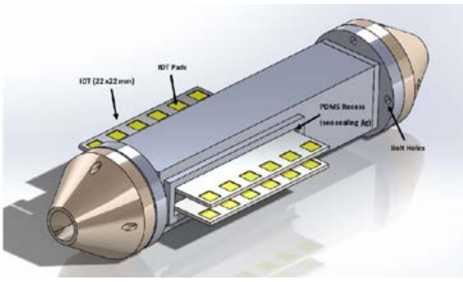
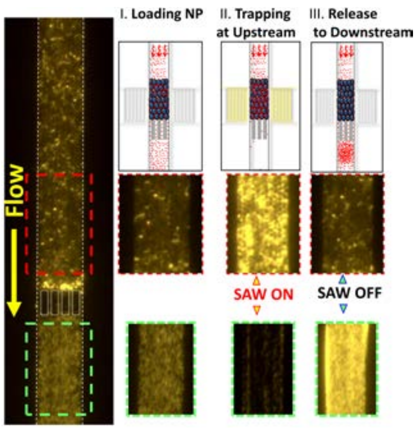


Figure 3. SWANS operating mechanism; test captions show the entrapment and then release of fluorescent nanoparticles using ultrasound in the microfluidic channel



The collected high-concentration batch can be released ‘on-demand’ by turning off the ultrasound activation and diverting to a collection reservoir.

The capturing process does not require any preparation or functionalisation of the microbeads nor polarisation of the target nanoparticles. This system depends only on the resonance of microbeads or micropillars, so it can be scaled up to handle larger sample volumes.

Early tests show that SWANS is able to increase the concentration of the sample to 50 fold within 10 seconds, capturing up to 97% of the target nanoparticles at its optimum frequency and power level. The return on concentration can increase by upscaling the size of the channel.

Unlike conventional ultracentrifugation or ultrafiltration methods that require multiple stage of loading and unloading and dismantling, SWANS filtration can work and integrate well into a continuous system, with adjustable collection and extraction cycles time.

Intellectual property: Australian provisional patent filed (AU2019901035).

THE OPPORTUNITY

Monash seeks a partner to optimise and adapt the system for application. We envisage an automated modular SWANS system for separation and purification of large volumes of different size samples that can replace ultracentrifugation or ultrafiltration.

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