Scientists lead development of novel acoustofluidic technology that isolates submicron particles

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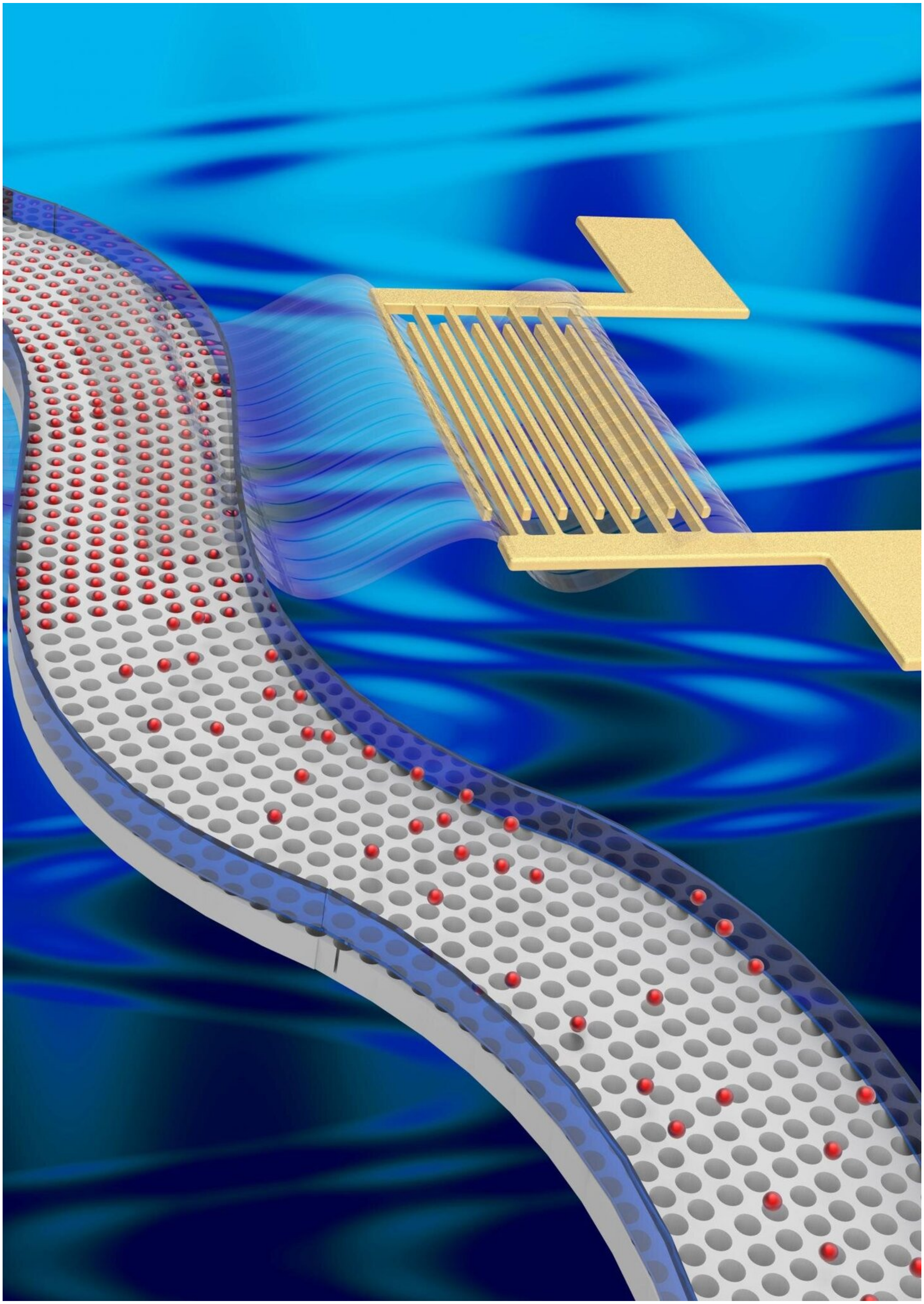

Massively multiplexed submicron particle patterning in acoustically driven oscillating nanocavities Credit: SUTD

Acoustofluidics is the fusion of acoustics and fluid mechanics that provides a contact-free, rapid and effective manipulation of fluids and suspended particles. The applied acoustic wave can produce a non-zero time-averaged pressure field to exert an acoustic radiation force on particles suspended in a microfluidic channel. However, for particles below a critical size the viscous drag force dominates over the acoustic radiation forces due to the strong acoustic streaming resulting from the acoustic energy dissipation in the fluid. Thus, particle size acts as a key limiting factor in the use of acoustic fields for manipulation and sorting applications that would otherwise be useful in fields including sensing (plasmonic nanoparticles), biology (small bioparticle enrichment) and optics (micro-lenses).

Although acoustic nanoparticle manipulation has been demonstrated, terahertz (THz) or gigahertz (GHz) frequencies are usually required to create nanoscale wavelengths, in which the fabrication of very small feature sizes of SAW transducers is challenging. In addition, single nanoparticle positioning into discrete traps has not been demonstrated in nanoacoustic fields. Hence, there is a pressing need to develop a fast, precise and scalable method for individual nano- and submicron scale manipulation in acoustic fields using megahertz (MHz) frequencies.

An interdisciplinary research team led by Associate Professor Ye Ai from Singapore University of Technology and Design (SUTD) and Dr. David Collins from University of Melbourne, in collaboration with Professor Jongyoon Han from MIT and Associate Professor Hong Yee

Low from SUTD, developed a novel acoustofluidic technology for massively multiplexed submicron particle trapping within nanocavities at the single-particle level.

The acoustofluidic device uses surface acoustic waves (SAWs) as the actuation source and contains an elastic nanocavity layer located at the interface of the microfluidic channel and the acoustic transducer. The generated SAW gives rise to acoustically-driven deformations in the nanocavities and produces a time averaged acoustic field that generates a nanoscale acoustic force gradients along the channel.

By taking advantage of this unique nanoscale acoustic force field to overcome the Brownian motion and acoustic streaming, the team was able to manipulate millions of individual nano- and submicron scale particles towards the nanocavities. Nanocavity layer implementation on the SAW actuator provides discrete trapping positions where individual nanoparticles can be confined by exposure to SAW and released with the cessation of SAW excitation. This is a fast-processing and contact-free trapping system with the potential for widespread application in sorting, patterning and size-selective capture of sub-micron and nanoscale objects.

This work has been published in *Small*, a top-tier, multidisciplinary journal, covering a broad spectrum of topics in nano- and microscale experimental and theoretical studies, and has been featured on the inside cover of the issue. SUTD graduate students and postdoctoral fellows, including Mahnoush Tayebi, Richard O'Rorke and Him Cheng Wong participated in this research project.

More information: Mahnoush Tayebi et al, Massively Multiplexed Submicron Particle Patterning in Acoustically Driven Oscillating Nanocavities, *Small* (2020). DOI: 10.1002/smll.202000462

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