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Surface acoustic waves are nanometer amplitude analogues of earthquakes that can be induced and made to propagate along the substrate of a piezoelectric material. The transmission of acoustic energy into a liquid as a result of the fluid-structural coupling gives rise to bulk fluid motion known as acoustic streaming, which can be harnessed for a wide range of microfluidic manipulations. Given the relatively large sound velocities in liquids, the advantage of using surface acoustic waves to drive microfluidics lies in the sheer speeds at which the fluid can be driven. We show that the surface acoustic waves can be exploited to pump liquids in microchannels at velocities up to several cm/s, typically one or more orders of magnitude larger than currently available micropump technology. Free droplets placed on the surface acoustic wave substrate can be translated rapidly without the elaborate design and control of complex electrode activation sequences associated with electrowetting schemes; such droplet translation strategies are used for microparticle/bioparticle collection and cell seeding in bioscaffolds. We also demonstrate the possibility for inducing rapid recirculation in these droplets for micromixing and bioparticle concentration/separation. In the latter, rich and peculiar complex pattern formation dynamics have been observed; colloidal islands assemble along the drop interface due to the coupled action between the acoustic force and capillary wave vibration on the colloidal particles. In addition, a transient metastable state is observed in which the system oscillates between colloidal island self-assembly in a quiescent fluid and their subsequent temporal erasure due to the generation of local streaming vortices in the antinodal positions of the surface and capillary waves.

Dr Leslie Yeo

Micro/Nanophysics Research Laboratory
Monash University
Clayton, Victoria

Thursday 14th February, 4pm

Theatre 2, Level 1
Alan Gilbert Building,
161 Barry St, Carlton

Nanoearthquakes and Microflows

Dr Leslie Yeo is a Senior Lecturer in the Department of Mechanical Engineering at Monash University, Australia. Together with Associate Professor James Friend, he established the Micro/Nanophysics Research Laboratory shortly after joining the department as a Lecturer in 2005. This follows a postdoctoral stint with Professor Hsueh-Chia Chang at the Center for Microfluidics and Medical Diagnostics, University of Notre Dame in 2003/4 and industrial experience as a Mathematical Modeller at Det Norske Veritas in 2002/3. Dr Yeo had previously completed his MEng and PhD degrees in Chemical Engineering at Imperial College London in 1998 and 2002, respectively. His PhD thesis, with Professor Omar Matar involved the theoretical investigation of Marangoni (surface tension gradient) driven drop coalescence dynamics and how it relates to phase inversion of liquid-liquid dispersions. For his work, Dr Yeo was awarded the Dudley Newitt prize for a theoretical/computational thesis of outstanding merit. His PhD studies were supported through two awards, namely the Overseas Research Scholarship and the University of London Knight Studentship in Science & Engineering.

MORE INFORMATION

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