Graphene-mediated microfluidic transport, atomization and nanofiltration via Rayleigh SAWs excitation

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Effective microfluidics transport and atomization is critical for further developments in a wide range of lab-on-a-chip applications such as pulmonary drug delivery, microelectronics cooling, mass spectrometry and DNA microarray printing. In this study, we demonstrated that performance for fluid transport and manipulation can be enhanced significantly by depositing a thin graphene film atop a chip scale piezoelectric substrate on which Rayleigh surface acoustic waves (SAWs) are excited. It is shown that SAWs are coupled through the entire thin graphene film and gives rise to antisymmetric Lamb waves in the film which enhance molecular diffusion and hence the liquid transport through the interstitial layers that make up the graphene film. By increasing the vibration amplitude above a critical threshold value, the strong substrate vibration displacement is able to force the liquid molecules out of the graphene film to form a thin fluid layer. When the fluid layer spreads to a sufficiently small aspect ratio, atomization then ensues as a consequence of surface destabilization. It is found that thin fluid layer with smaller aspect ratio can be obtained under the presence of graphene film atop the SAW device, thus improving its atomization efficiency. In short, we show several-fold improvement in the rate of fluid transport through the graphene film, and up to 55% enhancement in the rate of fluid atomization by simply depositing a thin graphene film atop the SAW device. Moreover, given the small interstitial spacing between graphene layers, we show that nanoparticles suspended in liquid can be effectively filtered as the liquid are transported through the graphene film during SAWs excitation.

References

[1] K. M. Ang, L. Y. Yeo, Y. M. Hung, and M. K. Tan, "Graphene-mediated microfluidic transport and nebulization via high frequency Rayleigh wave substrate excitation," *Lab on a Chip*, vol. 16 (2016), pp. 3503-3514.

Figures

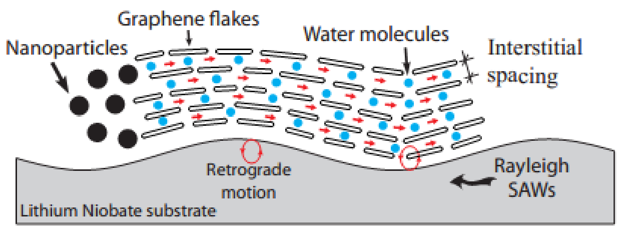

Figure 1: Water transport through graphene film is enhanced during SAWs excitation whilst preventing nanoparticles from passing through the small interstitial spacing between graphene layers as an efficient nanofiltration mechanism.