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Optics and Photonics Group Lunchtime Seminar

“Tunable hypersonic phononic crystals based on brush-particle assemblies: influence of topology”

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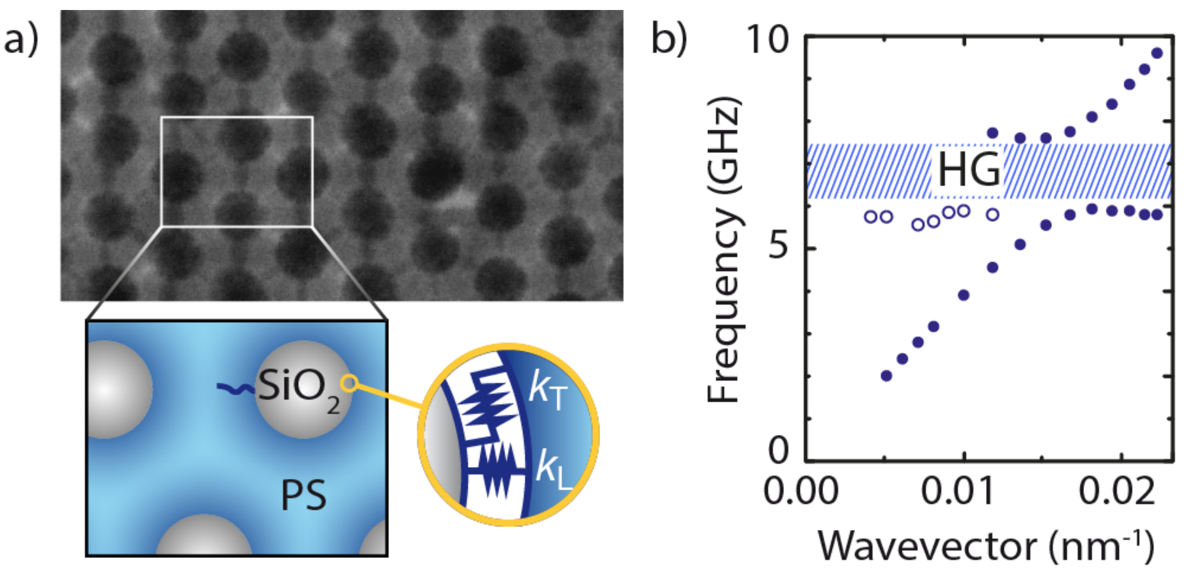

12:00pm Thursday 23rd March 2017
203 Tower Building
All Welcome

`http://optics.nottingham.ac.uk/wiki/Talks_2017`

Abstract

“Tunable hypersonic phononic crystals based on brush-particle assemblies: influence of topology”

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Periodic composite materials have been intensely investigated over the last two decades due to their capacity to modulate the flow of mechanical waves. Sub-micrometer colloidal particles can readily form 3D periodic structures by techniques such as vertical lifting deposition or flow induced alignment. Recently, the single component hybrid particle brushes have captured attention due to their unique properties and the ability to self-assemble by simply dropcast from solution. The ability to vary the brush topology via grafting density and length of the polymer chains on their surface introduces new properties and functions. For high grafting density, chain stretching near the solid interface introduces a density profile that can impact the structure and dynamics of the particle brush colloidal assembly. Here, we address the phononic behaviour describing the propagation of elastic waves (thermally activated phonons) through the colloidal crystal of SiO2-PS, and the relation to the elastic mechanical properties of such material. Using Brillouin light scattering, we have recorded the phononic band structure of the particle brush colloidal crystals with high and low grafting density for several PS lengths. The polymer grafts qualitatively modify the hypersonic (GHz) phonon propagation as contrast to the non-grafted particle-polymer colloidal crystals. Good agreement between theoretical and experimental behavior requires the introduction of a contact stiffness (through the use of imperfect boundary conditions) to describe the coupling between inorganic core and polymeric shell. The new band gap is attributed to the hybridization of the core eigenmodes with the effective medium acoustic mode of the crystal. The softening of the boundary conditions is also necessary to describe the particle brush eigenmodes. The dependence of the band structure with temperature is also analyzed.