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High frequency acoustics in nanostructures by spontaneous Brillouin light scattering

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We report on the dispersion of high frequency (GHz) acoustic excitations in three-dimensional colloidal crystalline or amorphous assemblies of sub-micron particles in different matrices by Brillouin light scattering (BLS) in order to explore the phononic and elastic properties of nanostructured materials. In air, we record eigenmodes of the individual particles, which are shown to be independent from the crystallinity and the composition of the sample but sensitively depend on the particle architecture (e.g core/shell silica/PMMA, hollow spheres) and their mechanical properties at nanoscale. In fluid matrices, the dispersion relations are recorded. We demonstrate the occurence of two hypersonic phononic band gaps of different nature. One is a Bragg gap appearing only in crystalline samples, the other one is a particle resonance-induced hybridization gap, which appears in crystalline samples along with the Bragg gap and alone in amorphous samples. Furthermore, we investigate the influence of filling fraction, crystallinity and monodispersity of size on the hypersonic behaviour of our samples.