Sensing nanomasses with resonant acoustic modes of 2D colloidal nanoplatelets

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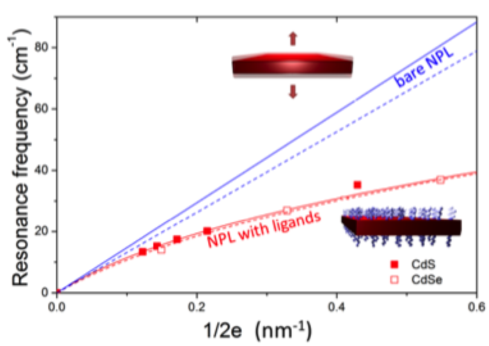
Resonant acoustic modes confined in semi-conductor nanoplatelets with nanometer thicknesses were studied using Low frequency Raman scattering (LFRS). At first order, the frequencies of these modes depend on the elastic constants of the material, thereby providing an elastic characterization of the nano-objects. If LFRS has been widely used to characterize the elasticity of spherical nano-objects [1 2] applications to 2D nanoplates are scarcer [3]. We show that probing low frequency Raman modes from large surface-to-volume ratio platelets turns out to allow sensing of nanomasses.



Acoustic resonance frequency of CdS and CdSe nanoplatlets as a function of their inverse thicknesses.

While mechanical exfoliation technique produces ligand-free atomic flat platelets[3], other chemistry-based approaches such as atomic layer deposition use surfactant molecules to ensure good stability of the colloidal cristals. Here we compare the acoustic resonance frequency of bare nanoplatelets produced by mechanical exfoliation to thoses of CdS and CdSe nanosheets stabilized with oleic acid. We show that the presence of surfactant molecules at the surface significantly lowers the resonance frequency of the system, the lowering factor scaling with the mass density of ligands lying at the surface of the platelets. This acoustic damping is not present in the samples with a free surface produced by mechanical exfoliation. Using a model of mass-damped resonator we discuss the possibility for the platelets acoustic frequency to be lowered by the combined contribution of ligand-mass damping effect and elastic softening induced by lattice relaxation.

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2. A. Courty et al., *Vibrational coherence of self-organized silver nanocrystals in f.c.c. supra-crystals*, Nature Materials 4, 395, 2005
3. Y. Zhao et al., *Interlayer Breathing and Shear Modes in Few-Trilayer MoS2 and WSe2*, Nanoletters 13, 1007, 2013