Low frequency Raman spectroscopy as a probe of nanostructural modification in thin CdSe nanoplatelets

Quentin Martinet[1], Justine Baronnier[1], Adrien Girard[1], Jérémie Margueritat[1], Tristan Albaret[1], Lucien Saviot[2], Alain Mermet[1], Benjamin Abecassis[3] and Benoît Mahler[1]

[1]*Institut Lumière Matière - Université Claude Bernard Lyon 1, UMR CNRS 5306, Villeurbanne, France.*
[2]*Laboratoire Interdisciplinaire Carnot de Bourgogne - Université de Bourgogne Franche-Comté, UMR CNRS 6303, Dijon, France.*
[3]*Laboratoire de Chimie ENS de Lyon, Université Claude Bernard Lyon 1, UMR CNRS 5182, Lyon, France.*

In the case of nanoparticles, acoustic waves are confined and resonant vibrations of the nanoparticle as whole thus emerge. These frequencies can be calculated for a free standing nano-object within the framework of continuum mechanics[1]. However, deviations to this model are appearing once the environment of the nano-objects change. In particular, we have recently observed that the breathing mode of CdSe nanoplatelet capped with oleic acid[2] is impacted by the ligand shell surrounding the particle inducing a down frequency shift. This effect is attributed to a mass load effect, meaning that the nanoplatelets can be used as nanobalances to determine the mass of the ligands on top of it.

In this study, we demonstrate the efficiency of the breathing mode of CdSe nanoplatelets as a molecular weight probe by varying the mass of the ligands attached to their surface (from octanethiol OT to octadecanethiol ODT). For relatively thick nanoplatelets, more than 6 monolayers (ML), frequency of the breathing mode follows the mass load, but when the thickness is reduced other effects have to be taken into account, due to a surface energy modification induced by the ligand layer.

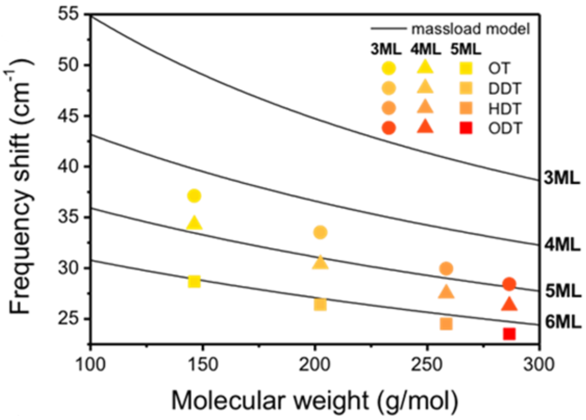

Figure 1. *Experimental dependency of the vibrational frequency as a function of the molecular weight of the ligands and the thickness of the nanoplatelets (colored markers), compared with the mass load model for different thicknesses (black lines).*

References:

[1] H. Lamb, *Proc. London Math. Soc.*, vol. s1-13 (1881), p.189.
[2] A. Girard *et al.*, *Nanoscale*, vol. 8 (2016), p.13251.