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The terahertz phonon properties of complex and hybrid materials

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One of the most exciting opportunities offered by mesoscale science is the possibility to grow complex structures out of nanoscale components to achieve new functionalities. In particular the development of devices active at extremely high (terahertz) frequencies is one of the frontiers of next generation phononics, since heat transfer mainly uses high-frequency phonons as carriers. Therefore, the control and manipulation of acoustic properties of mesoscale structures are of paramount importance for the development of a whole class of thermal devices such as thermal diodes, thermoelectrics and thermocrystals. To shed further light on phonon propagation in various prototypical soft matter samples we performed inelastic x-ray scattering (IXS) measurements on these systems using synchrotron base IXS spectrometers. Systems investigated include liquid crystals in different mesogenic phases, suspensions of nanoparticles and carbon nanotubes. In all cases, the results obtained point towards the possibility of effectively manipulating sound propagation at nanometer and picosecond scales thus disclosing new avenues for next generation phononics.

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