Elastic response in single nanowire

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Since the pioneer work of M. Orrit, investigating the dynamic response of single gold nanospheres, pump and probe investigations are considered as a powerful tool to get information's about confined acoustic modes in single small object.
Generally, the vibrational modes observed are assigned to breathing modes of the structure. According to the particle shape, additional extensional or flexural signatures have been also reported. The common denominator of all these previous studies is the clear evidence that particle coupling with the local environment leads to a huge damping rate. The particle/substrate interaction is at the origin of the acoustic energy transfer into the substrate. As a direct consequence, the resonator exhibits a low quality factor. To reach a high quality factor response, the elastic energy must be confined into the nanostructure and any mechanical coupling must be suppressed. Experimentally, this is achieved by investigating free standing nanostructures. Taking advantage of such geometry we have been able first to excite few breathing harmonic modes in copper single nanowire. The high spectral resolution achieved allowed to investigate nanoporous or core-shell single nanowire. Additionally, the 1D shape of our samples gives us the opportunity to analyze guided acoustics modes along the nanowire axis. We show that the observation of propagating acoustic waves in nanoscale waveguides provides additional elastic information's. Finally, nanowires could play the role of monochromatic acoustic sources when deposited on a substrate. The irradiated field is analysed using spatiotemporal imaging given the nanowire orientation thanks to the anisotropy field recorded.
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