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High frequency nano-optomechanical disk resonators in liquids

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Vibrating nano and micromechanical structures have been the subject of extensive research for the development of ultrasensitive mass sensors for spectrometry, chemical sensing and biomedical analysis. In short, the minimum detectable mass is proportional to the effective mass of the resonator and sensitivity improves if mechanical dissipation is reduced. Device miniaturization and dissipation control are therefore crucial. In liquids, the energy losses are high and the mass sensitivity is generally diminished dramatically. To circumvent this problem, novel structures have been proposed, such as micro-channels or micro-capillars where the liquid flows directly inside the resonators. While these structures indeed show lower mechanical dissipation, they can hardly be miniaturized. Here we demonstrate the potential of nano-optomechanical disk resonators in this context, in particular focusing on high-frequency radial breathing modes of these structures. Miniature semiconductor mechanical disks, with their high mechanical Q even in air (>103), their low mass (pg) and high mechanical frequency (GHz), present clear assets for mass sensing applications. However, they have not been operated in liquids so far. Here, we experimentally, numerically and analytically investigate the interaction of such vibrating disk resonators with arbitrary liquids, and propose models for both the frequency shift and dissipation of their mechanical modes. Nano-optomechanical disk resonators finally emerge as probes of rheological information of unprecedented sensitivity and speed, opening applications in high frequency sensing and fundamental science.

Biography

Eduardo Gil-Santos has completed his PhD at the age of 28 years old at the University Autonoma of Madrid, working in the BioNanoMechanics lab. He is currently a postdoctoral researcher at the University Paris Diderot, working in the OptoMechanics team of Matériaux et Phénomènes Quantiques laboratory. During his research career, he has focused on the study and development of micro- and nano-mechanical resonators, with applications in chemical and biological sensing, biomedical and fundamental quantum physics. He has published more than 15 papers and has given more than 10 talks at international conferences.

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