Dirty and Messy Cavity-Optomechanics

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We explore [1] an alternative route towards cavity-Optomechanics by exploiting Anderson-localized modes induced by fabrication disorder in slow-light waveguide. Our system etched in a suspended silicon membrane that incorporates an air defect (see Fig.1a) that confines the electromagnetic field very efficiently and couples it to in-plane mechanical motion. The resulting tightly confined Anderson-localized modes can be driven to enable mechanical amplification and self-sustained phonon lasing via optomechanical back-action. Our novel geometries [2,3] allow us to push the frequency of the phonon lasing up to 6.8 GHz resulting from confinement of the mechanical mode. We confirm the existence of this mode through a combination of cavity optomechanical techniques and Brillouin light scattering spectroscopy. The combination of disorder and cavity-optomechanical systems has been largely overlooked: it gives rise to very efficient optomechanical coupling which in combination with two-photon absorption nonlinearities gives rise to a rich and complex dynamical system.

References

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Figures

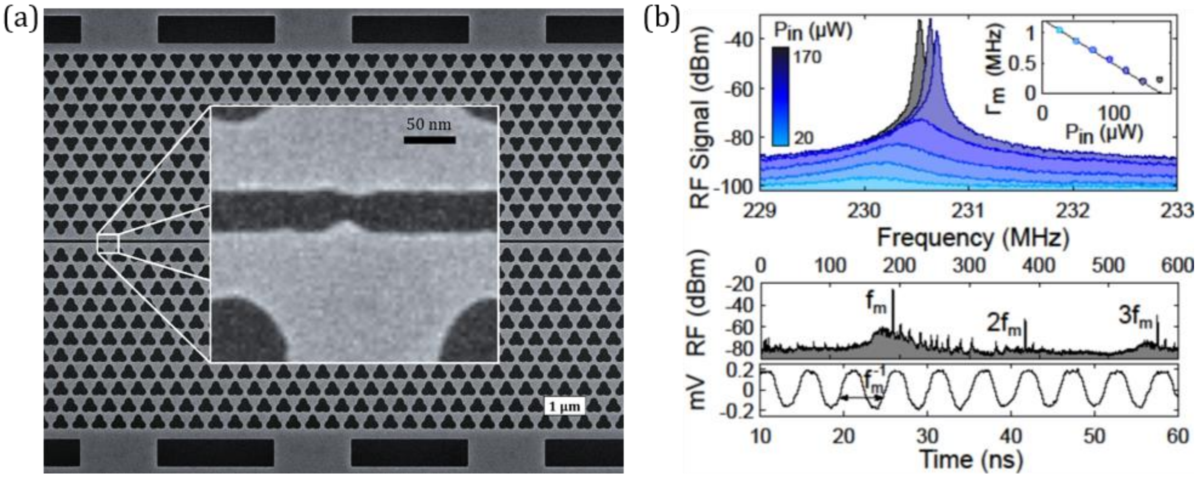

Figure 1. (a) Micrograph (top view) of an optomechanical nanostructure. Detail of the roughness due to the fabrication process which leads to the localization of the electromagnetic field within the air gap. (b) Coherent amplification of a vibrational mode of the structure by dynamical backaction: the linewidth of a mechanical mode with a frequency around 240 MHz (top panel) is narrowed down by red-detuning an external driving laser to an Anderson-localized optical mode. This dynamical backaction leads to a coherent amplification of the vibrational mode or phonon lasing (lower panel).