Terahertz optomechanical resonators with bi-material structures

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In this presentation, we will report optomechanical resonators operating in the terahertz domain. We fabricated and characterized "dog-bone" and "split-ring" resonators with a suspended portion that acts as an oscillating beam converting THz signal into MHz frequency domain, which will then be probed by a read-out laser with high precision. Thanks to the bi-material structure (Au on top of GaAs), our resonators give very strong responses to the incident THz wave and thus can be employed as a sensitive THz detector operating at room temperature [1], or as a transducer between THz domains and other spectral domains [2].

In addition to terahertz detection or transduction, our system can also serve as a great platform for fundamental research when the mechanical oscillation is forced into a strong non-linear regime by a RF drive. As a preliminary result, we observed a spring-softening effect on our sample, indicating a negative nonlinear term in the Duffing equation. Combining the THz source with the RF drive, we can also demonstrate that, by changing the power or the modulation frequency of the THz wave, the nonlinear behavior of mechanical oscillators will be modified. In addition, mechanical combs can be synchronously generated on several oscillating modes at different frequencies. These effects will be further studied in our ongoing work.

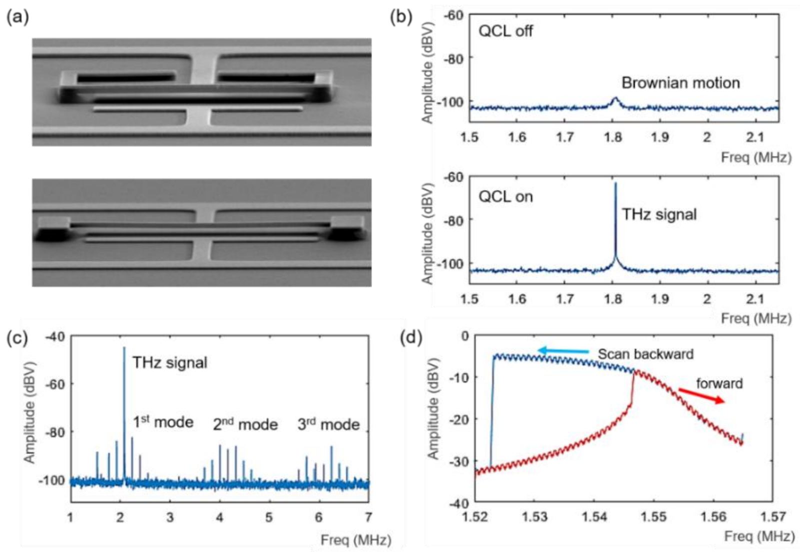

Fig. 1: (a) SEM images of split-ring (top) and dog-bone (bottom) resonator; (b) THz detection; (c) Comb generation in vacuum; (d) Duffing response in nonlinear regime.

References:

[1] C. Belacel et *al*. Nat Commun 8, 1578 (2017).

[2] A Calabrese et *al*. Nanophotonics 2019; 8(12): 2269–2277