Plasmon Optomechanical Switch

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In this work we theoretically demonstrate the use of a two-level optomechanical system actuated by plasmon-mediated optical forces as a reconfigurable nanophotonic switch. We have simulated a nanostructured suspended gold membrane allowing the normal excitation of a Surface Plasmon Polariton by patterning an air nanohole array [1]. By placing the membrane in the proximity of a reflecting substrate assembling a Fabry-Perot microcavity, we enter the strong coupling regime, obtaining a mode splitting which provides two stable mechanical states, accessible by tunning the illuminating wavelength [2]. It is also possible to dynamically actuate on the length of the cavity by introducing a mechanical actuation on the membrane by means of an induced harmonic displacement. The oscillatory movement of the suspended membrane can be manipulated via optomechanical amplitude modulation (cooling or amplification). The final stable state of the dynamical system can then be actively chosen, opening the door for the development of an optomechanical switch [2].

References

[1] Ramos, D., Malvar, O., Davis, Z. J., Tamayo, J. and Calleja, M. "Nanomechanical plasmon spectroscopy of single gold nanoparticles" Nano Letters 18 (11), 7165-7170, 2018

[2] Castro, I., Garcia-Martin, A. and Ramos, D., "Plasmon Optomechanical Switch" *In press*

Figures

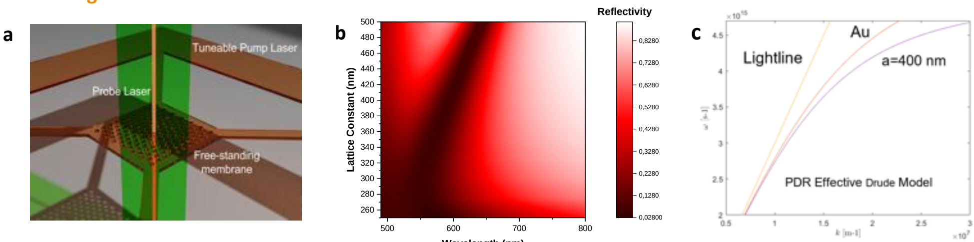

Figure 1: **a**. Schematic depiction of the optomechanical system. **b**. Color map of the membrane reflectivity as a function of the lattice constant of the nanohole arrays and the illuminating wavelength. The excitation of the Surface Plasmon Polariton is viewed as a reflectivity drop. **c**. Surface Plasmon dispersion relation calculated by an Effective Drude Model.

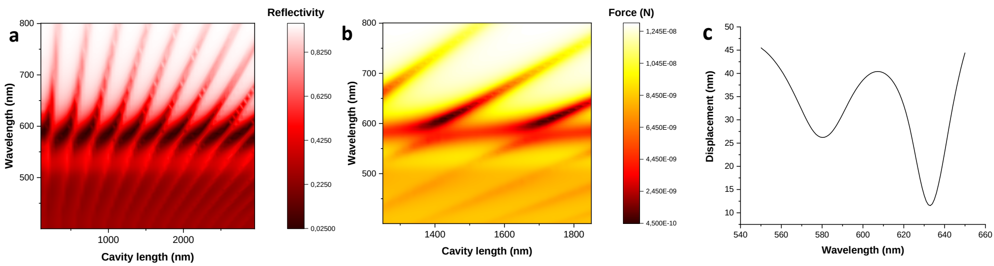

Figure 2: **a.** Reflectivity (in color) as a function of the illuminating wavelength (y-axis) and the cavity length (x-axis). **b.** Optical Force calculated as a function of the wavelength and the cavity length. **c.** Relative mechanical displacement of the mechanical structure placed 1500 nm over the reflecting substrate as a function of the wavelength of the pump laser.