Measurement of Casimir Forces between Silicon Nanostructures Fabricated Using Electron Beam Lithography

Lu Tang[1], M.K. Wang[1], C.Y. Ng[1], M. Nikolic[2], A. W. Rodriguez[2], C.T. Chan[1], H.B. Chan[1]

[1] **Hong Kong University of Science and Technology, Hong Kong**

[2] **Princeton University, US**

Email of Presenting Author: tanglulu@ust.hk

We report recent progress in measuring the Casimir force between silicon components of non-conventional shapes using an on-chip platform [1]. The device consists of a force-sensing micromechanical beam and a comb-drive actuator for controlling the distance (Fig. 1a). Each of the interacting surfaces contains an array of T-shaped protusions. The Casimir force gradient on the beam is detected by the shift in its resonance frequency as the two surfaces approach each other. In an earlier experimental run, the entire structure was created using optical (deep UV) lithography. Limited by the resolution of stepper, the corners of Tees are rounded (Fig 1b and 1c). Recently, we develop a new fabrication procedure including both optical and e-beam lithography. The nanoscale protrusions are defined by e-beam lithography while other large features are defined by optical lithography. Therefore, the shapes and relative positions of the two interacting surfaces are much more accurately defined compared to the earlier-generation device (Fig 1d and 1e). In the experiment, as the movable electrode is pushed towards the sensing beam by the comb drives, the two sets of the T-shaped protusions can interpenetrate. The lateral Casimir force between the top parts of the T-shaped structures produces in an overall interaction that is either apparently attractive or repulsive depending on the displacement. After balancing the residual voltage, we observe a non-monotonic dependence of the Casimir force on distance. The theory calculations using the boundary elements method and measurement of other non-conventional shapes are in progress.

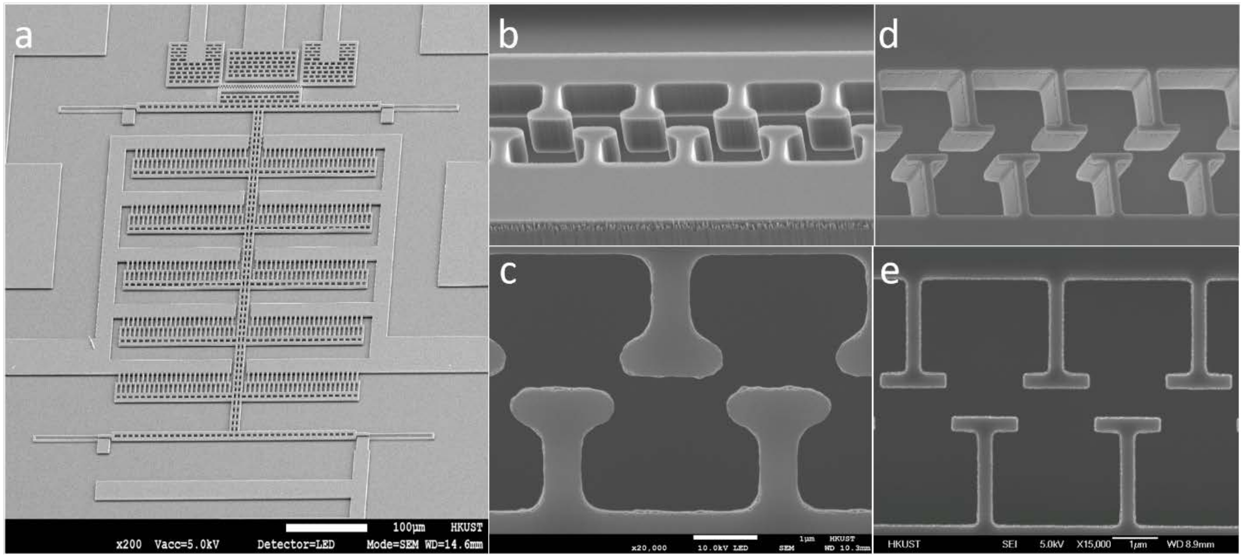

Figure 1 | Scanning electron micrographs. (a) The entire micromechanical structure. (b) The doubly clamped beam fabricated using optical lithography. (c) Top view of the beams in figure b. (d) The doubly clamped beam fabricated using e-beam lithography. (e) Top view of the beams in figure d.

1. J. Zou, Z. Marcet, A. W. Rodriguez, M. T. H. Reid, A. P. McCauley, I. I. Kravchenko, T. Lu, Y. Bao, S. G. Johnson and H. B. Chan, *Nature Communications* **4**, 1845 (2013).