Controlling buckling in a nanoscale beam using electrostatic effects

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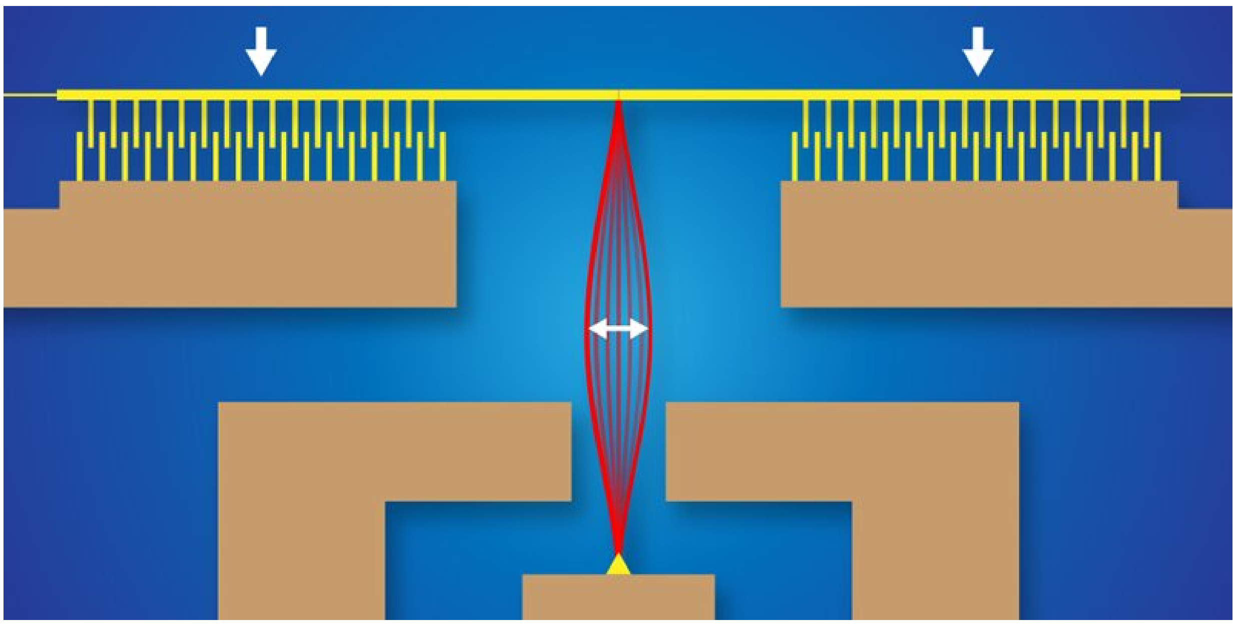

Buckling under pressure. Voltages control the buckling of a 150-nanometer-wide beam, as shown in this sketch of the device used by Hanay and coworkers. The ability to precisely alter the beam's deformation could be used in nanoelectromechanical devices and fundamental tests of thermodynamics. Credit: APS/Alan Stonebraker

A team of researchers from Bilkent University and Sabanci University SUNUM Nanotechnology Research Center has developed a way to control buckling in a nanoscale beam using electrostatic effects. In their paper published in the journal *Physical Review Letters*, the group describes the device they built and its possible uses.

In engineering terms, buckling is a deformation that occurs when pressure is applied to an object on two or more sides. The deformation typically occurs somewhere between the endpoints. In engineering applications, buckling usually means something has failed. But prior research has shown that buckling could be used to create devices such as nanoelectromechanical systems. In such systems, buckling could be used as a means of measuring acceleration or when building electromechanical relays. To build such devices, however, buckling must be both controllable and repeatable. In this new effort, the researchers have created a device that is capable of both.

The device the team built consisted of a silicon beam 40 micrometers long and 150 nanometers wide, which served as the buckling material. The beam was held in place by a ceiling and a floor. Pressure was applied to the ceiling by a comb drive, a type of actuator, which in turn applied downward pressure on the beam. Two comb-shaped structures were affixed to the ceiling—when voltage was applied, they were pulled closer together, resulting in increased pressure on the ceiling. The researchers also added electronic gates situated close to the beam on either side. As voltage was applied to the actuator above, electrostatic forces exerted pressure left or right. The result was a device that could force the tiny beam to buckle in a controlled fashion either right or left at up to 12 percent of the beam length.

The researchers suggest their device could be used as part of a very small mechanical pump—perhaps in medical applications. They plan to continue their work with the device by using it to test Landauer's principle—and down the line, they plan to test its possible use as a means for storing information in two-state memory devices.

More information: Selcuk Oguz Erbil et al. Full Electrostatic Control of Nanomechanical Buckling, *Physical Review Letters* (2020). DOI: 10.1103/PhysRevLett.124.046101

On *Arxiv*: Selcuk Oguz Erbil, et al. Full Electrostatic Control of Nanomechanical Buckling. arXiv:1902.05037v1 [physics.app-ph]: arxiv.org/abs/1902.05037