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Dynamic-Based Micro and Nano Devices and Phenomena

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Abstract: Miniature structures and devices have captured the attention of the scientific community for several decades for their unprecedented attractive features. Along with their distinct practical advantages, micro and nano devices are considered excellent platform to probe and reveal fundamental physical and mechanical phenomena in well-controlled environment [1].

Today, several micro-electro-mechanical systems MEMS devices are being used in our everyday life, ranging from accelerometers and pressure sensors in automobiles, radio-frequency (RF) switches and microphones in cell phones, and inertia sensors in video games. Due to the quest to boost sensitivity, reduce power consumption, and increase integration density, the past two decades have witnessed the emergence of Nano-electro-mechanical systems NEMS. With the increasing demand to embed more intelligence into various applications, MEMS and NEMS continue to play key role on advancing innovation.

Along with their great promise, micro and nano devices have brought new challenges and a wide spectrum of unexplained and less-understandable mechanical behaviors and phenomena. Because these devices employ moveable compliant structures and due to the interaction with short-range forces, many of these challenges are related to their dynamical behavior, which is mostly nonlinear.

The talk will overview some of the recent revealed intriguing phenomena at the micro and nano scale including modes veering, jumps, and internal resonances including three-one, two-one, and one-one [2,3], Figs. 1,2,3. Mode veerings, hybridization of modes, and localization will be also be discussed along with their potential for practical applications. The softening and hardening behaviors and the associated jumps will be shown with examples of proposed devices. The escape-from potential well will also be presented and its potential for realizing smart switches for gas sensing application will be shown. We will also discuss the static and dynamic behavior of actively tunable structures; which can be tuned using electrostatic and or/electrothermal actuation. The talk will end on future directions and perspectives.

Keywords: MEMS, arch, jumps, bifurcations, nonlinearity

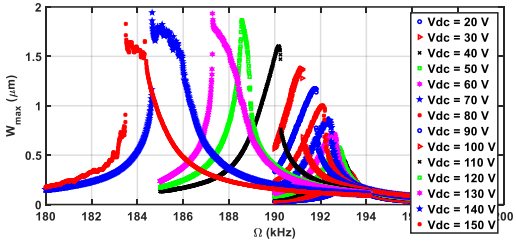

Fig. 1. Experimental data of a clamped-clamped beam actuated by electrostatic forces demonstrating transitions from softening to hardening behaviour.

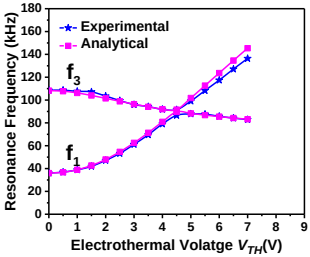

Fig. 2. Mode veering between the first and third modes of a micromachined arch.

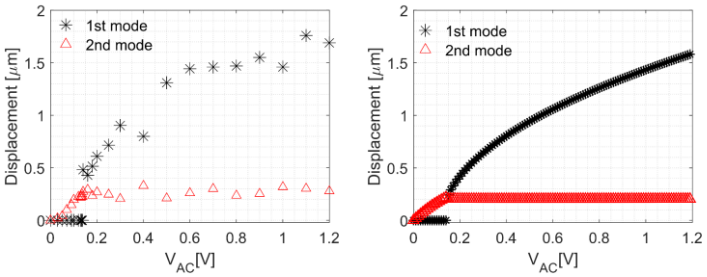

Fig. 3. The saturation phenomenon in a micromachined portal frame: (a) Measurements, (b) Simulations.

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References

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