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Mechanical Engineering Lecture in Mechanics

Harnessing Instabilities in Soft Dielectrics: From Artificial Muscle to Transformative Skin

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Widely used in insulating cables and electronics, soft dielectrics based on polymers and gels are playing critical roles in our modern electrified society. Owning to their merits such as mechanical compliance, high energy density and low cost, soft dielectrics also promise to replace traditional ceramic or metallic transducers for applications as diverse as artificial muscles in prosthetics and humanoid robots, stretchable sensors in wearable devices, flexible actuators in bio-integrated electronics, and broad-band energy harvesters. As a major failure cause, mechanical instabilities of soft dielectrics under electric fields, however, have greatly hampered the reliability and energy density of soft dielectrics, significantly limiting the scope of their applications and innovations.

This talk is focused on our recent discovery and understanding on various new modes of instabilities in soft dielectrics. We show that, contrary to traditional understanding in the field, soft dielectrics under mechanical constraints can indeed undergo localized instabilities when subjected to sufficiently high electric fields. Surprisingly, the new instability phenomena in soft dielectrics resemble creases in cerebral cortex and swelling gels or Taylor cones in electro-hydrodynamics, but follow a distinctly different scaling law. Based on the understanding, we enhance electric energy densities of many soft dielectrics over 10 times, by simply preventing the occurrence of mechanical instabilities. Conversely, the newly discovered instabilities can be rationally harnessed to design transformative skins with novel functions such as actively shedding off biofoulings and dynamically changing colors and textures to blend in different environments. Throughout the talk, I will elucidate how a combination of fundamental understanding in mechanics and bio-inspirations will lead to impactful applications.

Refreshments will be served before the seminar.
Please contact Tony Pulsone at pulsone@mit.edu with any questions.

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