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Electromechanical phase transition in dielectric elastomers under uniaxial tension and electrical voltage RUI HUANG, University of Texas at Austin, ZHIGANG SUO, Harvard University — Subject to forces and voltage, a dielectric elastomer may undergo electromechanical phase transition. A phase diagram is constructed for an ideal dielectric elastomer membrane under uniaxial force and voltage, reminiscent of the phase diagram for liquid-vapor transition of a pure substance. We identify a critical point for the electromechanical phase transition. Two states of deformation (thick and thin) may coexist during the phase transition, with the mismatch in lateral stretch accommodated by wrinkling of the membrane in the thin state. The processes of electromechanical phase transition under various conditions are discussed. A reversible cycle is suggested for electromechanical energy conversion using the dielectric elastomer membrane, analogous to the classical Carnot cycle for a heat engine. The amount of energy conversion, however, is limited by failure of the dielectric elastomer due to electrical breakdown. With a particular combination of material properties, the electromechanical energy conversion can be significantly extended by taking advantage of the phase transition without electrical breakdown.

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