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Flexoelectricity in nanostructures

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Crystalline piezoelectric dielectrics electrically polarize upon application of uniform mechanical strain. Inhomogeneous strain, however, locally breaks inversion symmetry and can potentially polarize even non-piezoelectric (centrosymmetric) dielectrics. Flexoelectricty–the coupling of strain gradient to polarization– is expected to show a strong size-dependency due to the scaling of stain gradients with structural feature size. In this study, using a combination of atomistic and theoretical approaches, we elucidate the "effective" size-dependent piezoelectric and elastic behavior of inhomogeneously strained non-piezoelectric and piezoelectric nanostructures. We argue, through computational examples, the tantalizing possibility of creating "apparently piezoelectric" nano-composites without piezoelectric constituents and the emergence of size-dependent "giant piezoelectricity" in paradigmatical nanostructures. Finally, we propose that flexoelectricity is an important and essential contributor to the intrinsic dead-layer effect in high permittivity ferroelectric based nanocapacitors.