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The Analysis of Flexoelectric Effect in Quantum-Dot system

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Abstract: The flexoelectric effect is investigated in quantum dot (QD) nano-sized structures. The lattice mismatch between QD and matrix results in non-uniform strains and presence of the strain gradients in the structure. The strain gradients induces the change of the polarization in QD structure as a consequence of the flexoelectric effect. When the dimensions of the QDs are of the same order of magnitude as the material length scale, gradient elasticity theory should be used to account for the size dependent of such nano-sized QDs. In this work the flexoelectric theory is applied for 3D analysis of QDs with the functionally graded lattice mismatch between the QD and the matrix. Governing equations in the gradient theory contain higher order derivatives than in conventional approaches which requires C^1 continuity of the shape functions and bring computational difficulties for 3D analysis. Therefore the higher order governing equations are decomposed in order to use C^0 continuity shape functions. The FEM is implemented to study the response of nano-sized QDs system subjected to electro-mechanical loading. The influence of the size effect parameter and flexoelectric coefficient on the electro-mechanical behavior of the QD structure is analyzed.

Keywords: Flexoelectricity; quantum dot; gradient elasticity; finite element method

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