MICROMECHANICAL ANALYSIS OF EFFECTIVE PROPERTIES OF QUANTUM DOT-EMBEDDED SMART NANOCOMPOSITE MATERIALS

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A general micromechanical model based on asymptotic homogenization technique is developed for the analysis of anisotropic quantum dot-embedded smart nanocomposites with piezoelectrically active constituents. A closed-form solution for the static three-dimensional coupled force balance and Maxwell's equations is derived with appropriate boundary conditions. The local fields (elastic and electric) and effective properties of a smart nanocomposite is determined by solving the three-dimensional local unit-cell problems. To illustrate the effectiveness of the model, the effective elastic, piezoelectric, and dielectric coefficients are obtained for a Zinc Oxide (ZnO) quantum dot (QD) glass fiber-reinforced polymer (GFRP) nanocomposite of laminated structure. The evaluation of these properties is accomplished by imposing homogeneous displacement and electric potential fields as boundary conditions. The effective material properties are calculated in relation to volume fraction of participating material constituents (fiber, polymer, QD). The micromechanically obtained results are then compared with those of the numerically obtained results in ABAQUS finite element method. The results demonstrate a close agreement between the analytical and numerical models.

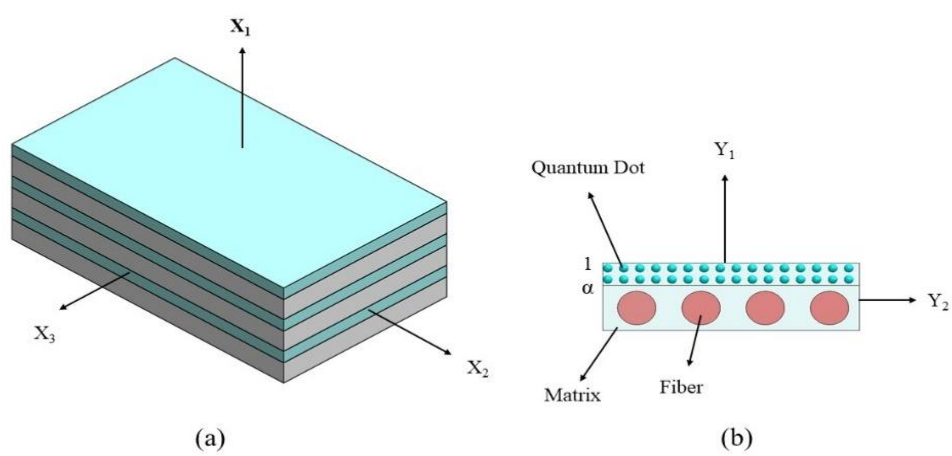

Figure 1: (a) Smart quantum dot-embedded laminated composite, and (b) corresponding unit cell.