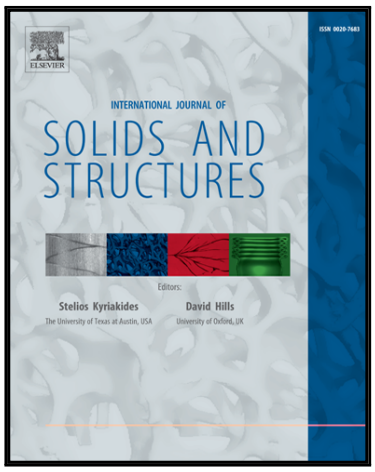

Bending deformation of multilayered one-dimensional hexagonal piezoelectric quasicrystal nanoplates with nonlocal effect

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Bending deformation of multilayered one-dimensional hexagonal piezoelectric quasicrystal nanoplates with nonlocal effect

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Abstract

Based on the nonlocal elasticity theory, the static bending deformation of one-dimensional (1D) hexagonal piezoelectric quasicrystal (PQC) nanoplates is investigated under surface electroelastic loadings. The general solutions for the extended displacement and traction vectors of a simply supported and homogeneous PQC nanoplate are derived by solving an eigenvalue problem reduced from the pseudo-Stroh formalism. By utilizing the propagator matrix method, exact closed-form solutions of multilayered 1D hexagonal PQC nanoplates are then obtained by assuming that the layer interfaces are perfectly contacted. Numerical examples for six kinds of sandwich nanoplates made up of piezoelectric crystals (PE), quasicrystal (QC) and PQC are presented to illustrate the effect of the nonlocal parameter and stacking sequence of the nanoplates on the phonon, phason and electric fields, which play an important role in designing new composite structures in engineering.

Keywords: nonlocal effect; quasicrystal; piezoelectricity; multilayered nanoplate; propagator matrix method

1. Introduction

Since the icosahedral quasicrystals (QCs) structure was first discovered by Shechtman et al. (1984) in Al–Mn alloys, the structural, electronic, magnetic, thermal and mechanical properties of QCs have been extensively investigated in experimental and theoretical analyses (Ovid'ko, 1992; Wollgarten et al., 1993; Fan and Mai, 2004). QCs are more attractive in applications as surface coatings and thin interphase layers attributing to their excellent properties such as low friction coefficient, low adhesion, high wear resistance and low level of porosity (Balbyshev et al., 2004; Thiel and Dubois, 1999). Fu et al. (2017) investigated the effects of processing parameter on the microstructure of Al-Cu-Fe-Cr QC coatings fabricated by selective laser melting from single layer to multilayers. Since plates are of very importance in structural design, many analytical solutions for plates have been obtained especially for laminates (Loredo, 2014; 2016; Vescovini, 2015; Guo et al., 2016a; 2016b; Pan, 2001; 2003). For QCs plates, great success has been made in recent years. For examples, Wei and He (2016) successfully synthesized a multilayered sandwich-like structure

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