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Application of the hybrid complex variable method to the analysis of a crack at a piezoelectric-metal interface

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Abstract

A plane strain problem for an electrically conducting interface crack between linear transversely isotropic piezoelectric and isotropic elastic conductor materials under remote mechanical loading is considered. The attention is focused on a hybrid complex variable method which combines the Stroh formalism for piezoelectric materials with the Muskhelishvili formalism for conducting isotropic elastic materials. This method is illustrated in detail for the open crack model and the contact zone crack model. Using special presentations of mechanical quantities via sectionally analytic functions, a combined Dirichlet–Riemann and Hilbert boundary value problem is formulated and solved analytically. Stress intensity factors as well as the crack tip energy release rate are found in a clear analytical form. Furthermore, transcendental equations for the determination of the realistic contact zone length and the location of the first interpenetration point have been obtained. A significant influence of the external mechanical loading on the crack opening and the stresses as well as the contact zone and interpenetration region lengths is observed. The dependencies of the mentioned values on the intensities of the mechanical loading are presented in tables and associated diagrams.

Keywords

Piezoelectric-metal joint, complex variable method, electrically conducting interface crack, contact zone

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