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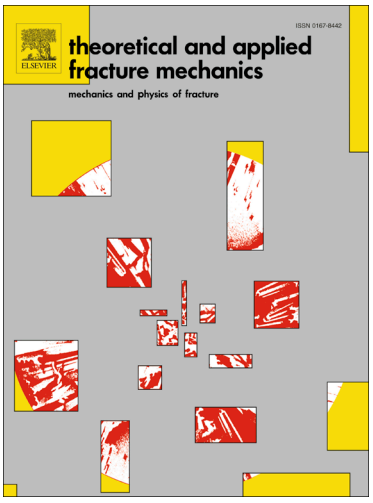

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Multiple Cylindrical Interface Cracks in FGM Coated Cylinders under Torsional Transient Loading

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Abstract

In the present study, the problem of multiple cylindrical interface cracks between a homogeneous circular cylinder and its functionally graded materials (FGM) coating under torsional impact loading is investigated. First, by using the Laplace and complex Fourier transforms, the solution for Somigliana-type dynamic rotational ring dislocation in a cylinder and its coating is obtained. Next, the distributed dislocation technique is employed to derive a set of Cauchy singular integral equations for multiple cylindrical interface cracks situated between the isotropic cylinder and its FGM coating. These integral equations are solved by Erdogan's collocation method; the dislocation densities on the faces of the cracks are obtained, and the results are used to determine dynamic stress intensity factors (DSIFs). Several examples are provided to study the influences of material nonhomogeneity constant, the FGM layer thickness and crack geometry configuration on the DSIFs at the tips of cracks and, the interaction between the cracks.

Keywords: Dynamic Stress Intensity Factors; Transient; Cylindrical Interface Cracks; FGM Coating; Dislocation Density.

1. Introduction

In recent years, functionally graded materials (FGMs) as coating and interfacial zones have been widely applied in structures exposed to harsh environments and severe thermal shocks. FGMs coating and FGMs interlayer help reduce mechanically- and thermally-induced stresses caused by material property mismatch; they also improve bonding strength. Typical applications of FGMs comprise thermal barrier coatings (TBCs) of high temperature components in gas turbines and as inter-layers in microelectronic and optoelectronic components. Therefore, fracture analysis of an FGMs coating-substrate system and an FGMs interlayer is an important design consideration and has attracted the attention of many researchers [1-3]. Delale and Erdogan identified the stress intensity factors for a crack situated in the interfacial nonhomogeneous layer between two dissimilar elastic half-planes under tension [4]. Ozturk and Erdogan determined axisymmetric solutions for a penny-shaped crack in an interfacial nonhomogeneous layer between two dissimilar elastic half-spaces under torsion [5] and under tension [6]. The axially symmetric problem of a cylindrical crack in the nonhomogeneous region of two coaxial elastic cylinder under Mode-III loading was studied by Han and Wang [7]. Choi *et al.* investigated the embedded collinear cracks in a layered half plane with a graded nonhomogeneous interfacial zone under static mechanical load [8]. Shbeeb and Binienda analyzed an interface crack in an FGM strip