Interface crack between two dissimilar piezoelectric solids

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Summary

It is well known that the coupling nature of piezoelectric materials has led to their wide applications. Interface failure is one of the most dominant failure mechanisms in laminated piezoelectric elements and structures. A meshless method based on the local Petrov-Galerkin approach is proposed, to solve the interface crack problem between two dissimilar piezoelectric solids. Permeable and impermeable electrical boundary conditions are considered on the crack faces. Stationary governing equations for electrical fields and the elastodynamic equations with an inertial term for two-dimensional (2-D) mechanical fields are considered. Nodal points are spread on the analyzed domain, and each node is surrounded by a small circle for simplicity. A Heaviside step function as the test functions is applied in the weak-form on the local subdomain. The local integral equations are derived. The spatial variations of the displacements and electric potential are approximated by the Moving Least-Squares (MLS) scheme. Numerical techniques based on the C1-continuity, such as in meshless methods, are expected to be more accurate than the conventional discretization techniques for homogeneous or continuously nonhomogeneous solids. However, higher order continuity of primary fields (displacements, electrical potential) would not yield jumps for secondary fields (gradients of primary fields), if the interface were not modeled. Such jumps occur due to the discontinuities of the material parameters on the interfaces of the joint laminates and the continuity of tractions and electric charge. Therefore, a special treatment for modeling discontinuities for piecewise homogeneous solids is required in the case of higher order modeling like in meshless approximations. After performing the spatial integrations, one obtains a system of ordinary differential equations for certain nodal unknowns. The system of the ordinary differential equations of the second order resulting from the equations of motion is solved by the Houbolt finite-difference scheme as a time-stepping method. Numerical examples will be presented and discussed to demonstrate the efficiency and the accuracy of the present method.