Discovery of the Fourth Singularity in Piezo-Electro-Magneto-Elastic Dissimilar Bi-material Composites, the Beauty of Mathematics

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Taking the electric–magnetic field inside the interface crack/defect into account, we investigate the interface crack problem of dissimilar piezo-electro-magneto (PEMO)–elastic anisotropic biomaterial composites under in-plane deformation. The conditions to decouple the in-plane and anti-plane deformation are presented for PEMO–elastic bi-material composites with a symmetry plane. Using the extended Stroh's dislocation theory of two-dimensional space and the analytic continuation principle of complex analysis, we turn the interface crack problem into a nonhomogeneous Hilbert equation in matrix notation. Four possible eigenvalues as well as four eigenvectors for the fundamental solution to the corresponding homogeneous Hilbert equation are found, so are four modes of singularities for the fields around the interface crack tip. These singularities are shown to have forms of $r^{-1/2\pm i\varepsilon_1}$ and $r^{-1/2\pm i\varepsilon_2}$, in which the bi-material constants ε_1 and ε_2 are proven to be real numbers for practical dissimilar PEMO–elastic bi-material Composites. Compared with the solution for the interface crack of dissimilar elastic bi-materials without electro–magnetic properties, two new additional singularities are discovered for the interface crack in the PEMO–elastic bi-material media. The electric–magnetic field inside the crack is solved by employing the "energy method," which is based on finding the stationary point of the saddle surface of the energy release rate with respect to the electro–magnetic field inside the crack. Closed form expressions for the extended crack tip stress fields and crack open displacements are formulated, so are some other fracture characteristic parameters, such as the extended stress intensity factors and energy release rate for dissimilar PEMO–elastic biomaterial solids. The discovery in this work could have applications in the failure and life predication of piezo-electro/magneto–elastic devices

Speaker's bio

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Professor Li received his Ph.D. from the School of Aerospace Engineering at the Georgia Institute of Technology, U.S.A. in 2004. His research interests are in the fields of new conception flight vehicles design, flight dynamics and control, as well as new composite structures, etc. Most of his research papers have been published in highly respected journals such as *Journal of Applied Mechanics*, the *AIAA Journal*, *the International Journal of Solids and Structures*, the *International Journal of Non-linear mechanics*, *IEEE Journal* etc. Professor Li has delivered over 30 presentations at national and international conferences, seminars and invited talks. He is a reviewer of several top ranked journals. Dr. Li is a member of the ASME, the AIAA, IEEE and a member of several other professional societies. He also is the recipient of numerous other awards.