ON THE ENERGY RELEASE RATE FOR AN ELECTRICALLY PERMEABLE INTERFACE CRACK IN A PIEZOELECTRIC QUASICRYSTAL

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A bimaterial composed of two 1D piezoelectric hexagonal quasicrystals with an electrically permeable crack $-a \le x_1 \le a$, $x_3 = 0$ along the material interface is considered. Phonon $\left(\sigma^\infty, \tau^\infty\right)$ and phason H^∞ remote loading and electrical displacement D^∞ providing plane strain conditions in $\left(x_1, x_3\right)$ plane are applied at infinity and an open crack model is adopted. In paper [1] the following presentations were obtained

$$\sigma_{33}^{(1)}(x_1,0) + m_{j5} H_{33}^{(1)}(x_1,0) + i m_{j1} \sigma_{13}^{(1)}(x_1,0) = \Theta_j^+(x_1) + \gamma_j \Theta_j^-(x_1), \qquad (1)$$

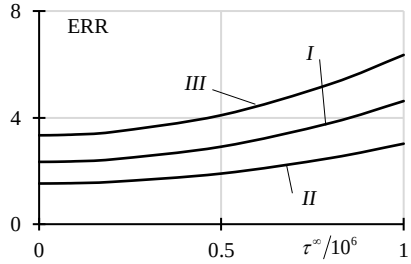
where $\Theta_j(z)$ are the functions analytic in the whole complex plane except the crack region; m_{ji}, n_{ji}, γ_j $(i, j = 1,3,5)$ are constants defined by the materials properties. Exact expressions for $\Theta_j(z)$ are found from the Riemann-Gilbert problem of linear relationship in the form

$$\Theta_j(z) = X_j(z)(\sigma_j^* - i\tau_j^*)(z - 2ia\varepsilon_j), \; X_j(z) = (z+a)^{-1/2+i\varepsilon_j}(z-a)^{-1/2-i\varepsilon_j}, \; \varepsilon_j = \ln\gamma_j / (2\pi). \qquad (2)$$

Phonon and phason quantities can be found by means of the formulas (1). According to the crack closure integral, the energy release rate (ERR) at a crack tip a can be presented in the form

$$G_a = \lim_{\Delta l \to 0} \frac{1}{2\Delta l} \left\{ \int_a^{a+\Delta l} \left[\sum_{i=1,3} \sigma_{i3}^{(1)}(x_1,0) \left\langle u_i(x_1 - \Delta l) \right\rangle + H_{33}^{(1)}(x_1,0) \left\langle W_3(x_1 - \Delta l) \right\rangle \right] dx_1 \right\} \qquad (3)$$

Substituting the obtained phonon and phason asymptotic expressions into (3) and performing the integration we arrive to the simple analytic formula for the ERR, N / m.



The variation of the ERR at the right crack tip for the bimaterial [1], $\sigma^\infty = 1\,MPa$, $H^\infty = 0$, $a = 100\,mm$ and different values of the remote shear stress τ^∞ are presented in Figure. Line *I* corresponds to the bimaterial mentioned above, lines *II* and *III* are drawn for the particular cases of the homogeneous material with the characteristics equal to the lower and upper materials, respectively.

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References

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