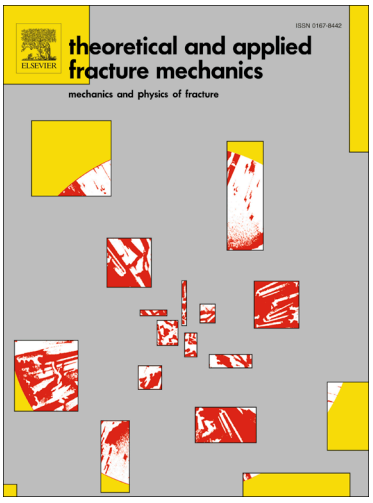

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Fracture characteristics of a cracked equilateral triangle hole with surface effect in piezoelectric materials

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Abstract A theoretical study is conducted on the fracture behavior of a cracked equilateral triangle hole with surface effect subjected to far-field antiplane mechanical load and inplane electric load. A rigorous analytical solution to the stress and electric displacement fields are obtained based on the theory of Gurtin-Murdoch surface model and conformal mapping technique. A closed form solution to the stress intensity factor, the electric displacement intensity factor and the energy release rate at the tip of crack are presented. Numerical examples are provided to reveal the variations of the electroelastic field intensity factors and the energy release rate with the size of triangle hole, the length of crack and the applied mechanical load and electrical load. The major results of the study are as follows: (1) The electroelastic field intensity factors at crack tip are dramatically size dependent when the size of the cracked triangle hole is at nanoscale. The present solution approaches classical electroelastic theory when the length of cracked equilateral triangle hole has large characteristic dimensions. (2) With the increase of the length of crack, the electroelastic field intensity factors first increase rapidly, and then slowly decrease, and finally stabilize. (3) When considering surface effect, the stress and electric displacement intensity factors depend on the applied mechanical-electrical loads, which is different from that of the classical electroelastic fracture theory. (4) The normalized energy release rate increases with the increase of the size of the cracked triangle hole. (5) The influences of the applied mechanical load on the normalized energy release rate depend on whether the applied electrical load is positive or negative. (6) With the increase of the applied electrical load from negative to positive, the normalized energy release rate release rate first increases and then decreases. Very high positive and negative applied electrical loads shield the normalized energy release rate.

Key words Surface effect; piezoelectric materials; cracked hole; stress intensity factor; electric displacement intensity factor; energy release rate; size dependent

1. Introduction

Hole defects (such as bolt holes, rivet holes, groove holes and weight loss holes, etc.) often be designed artificially in engineering structures and mechanical parts during manufacturing and

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