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Finite element analysis of boron nitride nanotubes' shielding effect on the stress intensity factor of semielliptical surface crack in a wide range of matrixes using RVE model

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ABSTRACT

In terms of fracture toughening mechanisms, this study carried out a finite element analysis to determine the shielding effect of boron nitride nanotubes (BNNTs), as a reinforcement element, on a preexisting semielliptical surface crack in both soft (polymeric) and stiff (ceramic and metal) materials. The BNNTs were distributed randomly using the random sequential adsorption algorithm in the hypothetical matrixes. The prepared representative volume elements (RVEs) contained 2%, 5%, and 8% volume fractions of BNNTs. The elastic modulus ratio of BNNTs to the RVEs matrixes' elastic modulus was set for 11 levels as 1, 5, 10, 20, 40, 100, 200, 500, 1000, 5000 and 10000. Then, semielliptical cracks at the crack depth to crack width ratio of 0.2, 0.4, 0.6 and 1 were embedded on the RVEs' surface to evaluate the mode I stress intensity factor, or K_I value. The results showed that a higher mismatch difference between the matrix and BNNTs' elastic modulus caused further reduction in K_I value. Moreover, in softer materials, the BNNTs' volume fraction changes were more effective