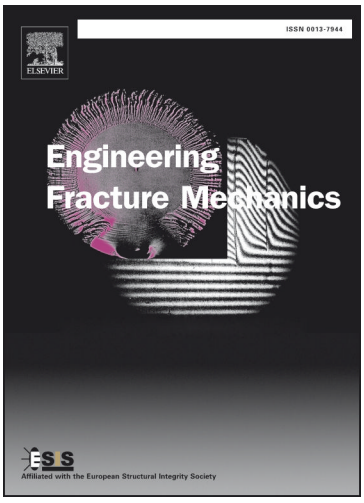


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PII: S0013-7944(17)30911-6
DOI: https://doi.org/10.1016/j.engfracmech.2017.11.021
Reference: EFM 5759

To appear in: *Engineering Fracture Mechanics*

Received Date: 4 September 2017
Revised Date: 11 November 2017
Accepted Date: 12 November 2017

Please cite this article as: Zhang, Y., Guo, L., Huang, K., Bai, X., Pang, J., Zhang, Z., A numerical method for the thermal-shock crack problems of nonhomogeneous materials with inclusions based on an interaction energy integral method, *Engineering Fracture Mechanics* (2017), doi: https://doi.org/10.1016/j.engfracmech.2017.11.021

# A numerical method for the thermal-shock crack problems of nonhomogeneous materials with inclusions based on an interaction energy integral method

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**Abstract**: Nonhomogeneous materials, especially for particulate composites, usually contain defects such as voids and debonding introduced during manufacturing process. Due to existence of defects, nonhomogeneous materials are prone to fracture failure under thermal shock loading. This paper aims to develop a set of methods for analysing the thermal-shock crack problems of nonhomogeneous material plates (NMPs) with inclusions. A modified domain-independent interaction energy integral method (IEIM) is developed to obtain the mixed-mode transient thermal stress intensity factors (TSIFs). Then the IEIM, the extended finite element method (XFEM) and the finite difference method (FDM) are combined together to address a thermal-shock crack problem of a NMP with an inclusion. With the methods, the influences of the inclusion on the transient mixed-mode TSIFs are investigated. The results show that the present method can be applied to solve the thermal shock crack problem effectively. Furthermore, the relations between the mixed-mode TSIFs and model parameters including material constants as well as locations of the inclusion are established. It is found that the thermal expansion coefficient and Young's modulus of the inclusion affect the mixed-mode TSIFs in a dominant manner in comparison with other factors such as the specific heat, heat conductivity and density of the inclusion affect the TSIFs slightly. Specifically, the critical normalized distance, beyond which the influence of the inclusion on the mixed-mode TSIFs is negligible, is revealed. The present work will be significant for fracture mechanics analysis and design of nonhomogeneous materials with inclusions.

***Keywords:*** Nonhomogeneous materials; Thermal shock; Interaction energy integral

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