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Effect of the Incorporation of Cylindrical Inhomogeneities on the Strength Distributions of Brittle Materials

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Cylindrical inhomogeneities are often incorporated into engineering ceramics (e.g., fibers, vias, electrical feed-throughs'). The thermal expansion mismatch between the matrix and inhomogeneity creates a state of localized stress. We show that for radial cracks around such inhomogeneities, there may be conditions of crack stability even in the presence of an external, destabilizing field. This stability, and the nature of the stress intensity factor due to local stresses, modifies the strength distribution of the matrix. A fracture-mechanics based approach allows the prediction of the new strength distributions. As an illustration, results for commonly used ceramic-metal inhomogeneity material pairs are discussed. Depending on the inhomogeneity/flaw size ratio, the new strength distributions can have lower or higher strength variability than the matrix. If the inhomogeneity radius (R) is chosen such that a majority of the cracks in the matrix are < 0.25R, the material will have the highest possible strength and reduced variability.

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