

ABSTRACT

Materials play a crucial role in industrial production. With the improvement of social productivity, the demand for materials is increasing rapidly. As an advanced branch in the field of materials, functionally graded material (FGM) undertakes the task of providing advanced performance materials. The gradient structure of FGM not only enhances the strength, toughness, and wear resistance of the composite but also avoids fatigue, corrosion, stress corrosion cracking, and fracture. As soon as the concept of FGM was introduced it received worldwide exploration and application in several fields like aerospace, nuclear energy, biology, electromagnetism, optics, etc. The increasing use of FGM necessitates a thorough investigation of the fracture tendency of this non-homogeneous composite.

For a thorough understanding of fracture mechanism and proper insight into the different modes of fracture in FGM, analytical treatment of the problem is required to analyze its strength in the pre-failure state. The occurrence of a crack may depend on various parameters like the composition of the material, applied external stress, temperature, stress intensity factor (SIF), stress magnification factor (SMF), strain energy release rate (SEER), and others. A set of mathematical formulae relating relevant parameters like composite geometry, flaw size, the degree of applied load, and the properties of the material is formed. The degree of accuracy of the mathematical results helps to determine the success rate of results in handling real-world problems.

In general integral transform methods are useful during solutions of the problems concerned with cracked FGM composite. When the problems are reduced into singular integral equations, the appropriate techniques will be used to solve those singular integral equations and also to find the physical quantities like SIF, SMF, SEER, and others. In fracture-oriented failures such as subcritical crack growth and static or dynamic fracture, the crack driving force would heavily depend on the thickness and constitutive properties of the interfacial region, the size, location, and orientation of the crack, and mechanical properties of the adjacent materials as well as on the magnitude of the external loads and geometry of the media.

In this thesis I have tried to explore the fracture mechanics of different models consisting of FGMs using mathematical tools and techniques to provide support to material and space scientists, manufacturing, design, and nuclear engineers.