Investigation on the influence of Localized Unbonded-areas on the Crack Growth Characteristic of Diffusion Bonded Titanium Alloy Laminates

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Abstract

Preformed unbonded-areas within the interface of diffusion bonded titanium alloy laminates can disturb the stress distribution when the crack growing in their neighborhood, thus, these performed unbonded-areas may change the crack growth characteristics. The motivation of this paper is to investigate the influence and intend to find the rules how the geometric parameters of unbonded-areas affect the crack growth characteristics of diffusion bonded laminates. The specimens considered in this paper are made of Ti-6Al-4V titanium alloy with localized unbonded-areas and their crack growth characteristics were analyzed under tension-tension cyclic loading using the numerical simulation techniques based on extended finite element method (X-FEM). The results are compared with the experiments, and the agreement of numerical and experimental results illustrated that the exact crack growth characteristics can be captured by using X-FEM. The influence of the geometric parameters, such as the size, location and number of the unbonded-areas, were analyzed and synthesized. The results illustrate that preforming unbonded-areas do influence the crack growth characteristics and fatigue life, and the influence extent is tremendously dependent on the geometric parameters of the unbonded-areas. The fatigue life can be prolonged effectively if the unbonded-areas are arranged reasonably in the interfaces of diffusion bonded titanium alloy laminates. In the design of the laminate with unbonded-area, the surface layer should be thinner. The crack in the structure always initiates from the surface. So the thinner surface layer can make the unbonded-area works at an early time. The first unbonded-area plays the leading role in inhibiting crack growth.

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