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### 钛合金结构损伤容限设计可行性研究

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### Feasibility Study on Damage Tolerance Design of Titanium Alloys

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摘要

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**摘要** 对飞机结构常用金属材料损伤容限特性进行了对比分析, 针对TC4和TA15损伤容限特性较差的缺点, 研制出两种超低间隙(ELI)钛合金TC4ELI和TA15ELI, 并对其进行了结构损伤容限设计可行性论证。进行了两种超低间隙钛合金和普通钛合金裂纹扩展寿命、剩余强度和疲劳全寿命对比实验。实验结果表明: 具有片层组织的超低间隙钛合金相对于普通成分钛合金断裂韧性和裂纹扩展特性有明显改善, 剩余强度和疲劳全寿命相当; 应力水平相当时, 超低间隙钛合金工程可检裂纹扩展寿命比航空结构中常用铝合金稍长。因此, 对于超低间隙钛合金TC4ELI和TA15ELI可以进行损伤容限设计。

**关键词:** 钛合金 损伤容限 结构设计 超低间隙 裂纹扩展 疲劳全寿命

**Abstract:** The damage tolerance properties of metal materials commonly used in aircraft structures were compared and discussed. In view of the poor damage tolerance characteristics of TC4 and TA15, two extra low interstitial (ELI) titanium alloys TC4ELI and TA15ELI were developed. A feasibility study was performed on the damage tolerance structure design for the ELI titanium alloys. The crack growth life, residual strength, and total fatigue life experiments were conducted on both the two ELI titanium alloys and common titanium alloys. The experimental results show that: compared with the common types, the ELI titanium alloys have higher fracture toughness and slower crack propagation rate, similar residual strength and total fatigue life. Under equivalent loading, the detectable crack growth life of the ELI titanium alloys is longer than that of the aluminum alloys. Consequently, in aircraft structure design, the damage tolerance method could be adopted with the ELI titanium alloys TC4ELI and TA15ELI.

**Keywords:** titanium alloys damage tolerance structural design extra low interstitial crack growth total fatigue life

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