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The nature and the mechanism of crack initiation and early growth for very-high-cycle fatigue of metallic materials – an overview

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Abstract

Very-high-cycle fatigue (VHCF) is the fatigue damage and failure beyond 10^7 loading cycles. Crack initiation of VHCF for metallic materials is commonly from the interior of specimens and possesses a unique feature of fish-eye (FiE) containing a fine-granular-area (FGA). It is regarded that FGA together with FiE is the characteristic region of crack initiation for VHCF, because it consumes more than 95% of total fatigue life and the value of stress intensity factor range for this region keeps constant for a given material. The aim of this overview is to summarize the research progress on the crack initiation characteristics and the related mechanisms for VHCF of metallic materials. After a brief introduction to the origination of VHCF research in 1980's, this overview contains the following parts: Characteristics of crack initiation region for VHCF, Characteristic region and intrinsic dimensions of crack initiation for VHCF, The formation mechanism and the model of crack initiation region, The new model of Numerous Cyclic Pressing to explain the formation mechanism of FGA, and Verification of proposed NCP model. In the descriptions, the two essential aspects are especially focused: the nature of crack initiation region for VHCF, and the mechanism for the formation of crack initiation region.

Keywords: Very-high-cycle fatigue; Fatigue crack initiation; Fine-granular-area; Nanograins; High-strength steels; Titanium alloys

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