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Surface Nanostructure Developed by Ultrasonic Shot Peening and Its Effect on Low Cycle Fatigue Life of the IN718 Superalloy

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Abstract : Inconel 718 (IN718) is a high strength nickel-based superalloy designed for high-temperature applications up to 650 °C. It is widely used in gas turbines of jet engines and related aerospace applications because of its good mechanical properties and structural stability at elevated temperatures. Because of good performance ratio and excellent process capability, this alloy has been used predominantly for aeronautic engine components like compressor disc and compressor blade. The main precipitates that contribute to high-temperature strength of IN718 are γ′ Ni_3(Al, Ti) and mainly γ′′ (Ni_3 Nb). Various processes have been used for modification of the surface of components, such as Laser Shock Peening (LSP), Conventional Shot Peening (SP) and Ultrasonic Shot Peening (USP) to induce compressive residual stress (CRS) and development of fine-grained structure in the surface region. Surface nanostructure by ultrasonic shot peening is a novel methodology of surface modification to improve the overall performance of structural components. Surface nanostructure was developed on the peak aged IN718 superalloy using USP and its effect was studied on low cycle fatigue (LCF) life. Nanostructure of ~ 49 to 73 nm was developed in the surface region of the alloy by USP. The gage section of LCF samples was USPed for 5 minutes at a constant frequency of 20 kHz using StressVoyager to modify the surface. Strain controlled cyclic tests were performed for non-USPed and USPed samples at $\pm\Delta\varepsilon t/2$ from ±0.50% to ±1.0% at strain rate ($\dot{e}$) 1×10^{-3} s^{-1} under reversal loading (R=−1) at room temperature. The fatigue life of the USPed specimens was found to be more than that of the non-USPed ones. LCF life of the USPed specimen at $\Delta\varepsilon t/2=\pm0.50\%$ was enhanced by more than twice of the non-USPed specimen.

Keywords : IN718 superalloy, nanostructure, USP, LCF life
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