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Coupled Effect of Pulsed Current and Stress State on Fracture Behavior of Ultrathin Superalloy Sheet

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Abstract : Superalloy ultra-thin-walled components occupy a considerable proportion of aero engines and play an increasingly important role in structural weight reduction and performance improvement. To solve problems such as high deformation resistance and poor formability at room temperature, the introduction of pulse current in the processing process can improve the plasticity of metal materials, but the influence mechanism of pulse current on the forming limit of superalloy ultra-thin sheet is not clear, which is of great significance for determining the material processing window and improving the micro-forming process. The effect of pulse current on the microstructure evolution of superalloy thin plates was observed by optical microscopy (OM) and X-ray diffraction topography (XRT) by applying pulse current to GH3039 with a thickness of 0.2mm under plane strain and uniaxial tensile states. Compared with the specimen without pulse current applied at the same temperature, the internal void volume fraction is significantly reduced, reflecting the non-thermal effect of pulse current on the growth of micro-pores. ED (electrically deforming) specimens have larger and deeper dimples, but the elongation is not significantly improved because the pulse current promotes the void coalescence process, resulting in material fracture. The electro-plastic phenomenon is more obvious in the plane strain state, which is closely related to the effect of stress triaxial degree on the void evolution under pulsed current.

Keywords : pulse current, superalloy, ductile fracture, void damage
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