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论文



# 含孔薄板孔边疲劳裂纹的萌生和扩展

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# INITIATION AND PROPAGATION OF FATIGUE CRACK IN EDGE REGION OF HOLE IN A SHEET WITH CENTRAL HOLE

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**摘要** 测试了 Ni基高温合金 GH41 69含孔薄板试件不同应力幅下的低周疲劳寿命,给出了孔边最大应力幅相同时,应力集中因子改变对试件疲劳寿命的影响。结合断口 SEM分析,探讨了应力集中条件下,疲劳短裂纹的萌生和扩展方式。试验结果表明,疲劳裂纹以滑移方式在孔壁与试样表面相交的棱上萌生;萌生期依赖于孔边应力幅的大小,与孔径无关。但疲劳裂纹扩展速率与孔边局部区域的应力分布有关。在孔边应力幅相同的情况下,孔边应力集中因子较大的试样裂纹扩展速率大,疲劳寿命分布带略低于孔边应力集中因子较小的试样。短裂纹阶段,疲劳裂纹以角裂纹的形式向内扩展;长裂纹阶段,疲劳裂纹以穿透裂纹的形式进行扩展。稳定扩展阶段疲劳裂纹以穿晶的韧性撕裂方式发展,但在靠近失稳扩展区域疲劳裂纹呈准解理断裂方式扩展。试验未观察到疲劳短裂纹群的连接与合并现象

**关键词：** 应力集中 裂纹萌生 断口分析

**Abstract：** The low cycle fatigue lifetimes of nickel-base alloy GH4169 were tested under different stress amplitudes, with a sheet specimen containing a central hole. The effects of the stress concentration factor nearby the central hole on the fatigue lifetime were compared on the same maximum stress amplitude. The initiation and propagation of fatigue cracks in the stress concentration field were investigated with SEM. It was found that the initial fatigue crack nucleated at the cross edge of the hole and surfaces of the specimen by sliding. The initiation periods of specimens were predominantly dependent on the stress amplitude near the hole and less dependent on the diameter of the hole. But the crack propagation rates exhibited a correlation with the stress distribution near the hole. Under the same stress amplitude, the higher the stress concentration factor nearby the hole, the faster the crack propagation rate. The scatters of fatigue lifetime of bigger hole diameter specimens were slightly lower than those of smaller hole specimens. Cracks grew in the form of an edge crack in the short fatigue crack and developed in the form of a penetrated crack in the long fatigue crack. In the steady propagating stage, the fatigue crack extended in a toughness tearing way of crystal penetrating. Near to unstable propagating, the crack fast stretched out by quasi-cleavage. The connection and coalescence of short fatigue crack clusters were not observed.

Keywords： st ress concent rat ion crack init iat ion rup ture analysis

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