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Texture-dependent near-threshold fatigue crack growth properties of wrought magnesium alloy AZ31

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Due to their enormous lightweight potential, magnesium materials offer the possibility of reducing energy consumption in the transport sector and creating space for innovative mobility concepts. The outstanding property advantage over common lightweight materials such as aluminum is the reduced density, which is however counteracted by reduced static and cyclic strength. To enable the use of magnesium alloys nevertheless, the fatigue behavior and, consequently, the behavior of fatigue cracks in wrought magnesium alloys must be understood precisely. In this way, it is possible to safely predict to which extent naturally cracked components can be tolerated under very high cyclic loading.

In the investigations presented, the fatigue crack growth behavior of long cracks in a highly textured magnesium sheet is investigated at very low loading in different orientations to the rolling direction. Fatigue tests were performed on an ultrasonic fatigue test system with a loading frequency of 20 kHz and a stress ratio of R = -1 using pre-cracked single-edge notched specimen. The use of the ultrasonic fatigue technique allowed the investigation of near-threshold crack growth at crack growth rates of less than 10-12 m/load cycle in a very short time. In the first step, fatigue crack growth thresholds ΔK_{th} were determined for different sheet directions. Subsequently, crack growth was investigated at very low loading with approximately constant stress intensity factor ΔK near the determined threshold. This method allows even long cracks to propagate microstructurally-driven through the material with a plastic zone of constant size. Thus, the influences of texture and other magnesium-specific microstructural features can be closely observed. The crack growth investigations are followed by fracture surface analyses and EBSD investigations. This way, direction-dependent influences of the microstructure as well as the active deformation mechanisms can be revealed.