Effect of Grain Size and Force Ratio on Fatigue Crack Propagation of Commercially Pure Titanium with Harmonic Structure

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Fatigue crack propagation tests were conducted on cold rolled commercially pure titanium with a bimodal harmonic structure to clarify the effects of the grain size and force ratio.[1] As shown in Fig. 1, the threshold stress intensity factor range ΔK_{th} for the L-T orientation was always lower than that for the T-L orientation, and ΔK_{th} was lower for a higher force ratio and a higher rolling reduction for either rolling reduction. Crack closure resulting from the roughness of the fracture surface can be partially explained by the above effects, and the effective threshold stress intensity factor range $\Delta K_{eff,th}$ also depended on the same factors, whereas the effects were smaller than those for ΔK_{th}. As shown in Fig. 2, the crack opening stress intensity factor $K_{op,th}$ and effective threshold stress intensity factor range $\Delta K_{eff,th}$ linearly increased with the square root of the average grain size in the Shell region, which decreased with rolling reduction. Thus, the threshold condition of the harmonic structured material is considered to be determined by the average grain size in the Shell region.

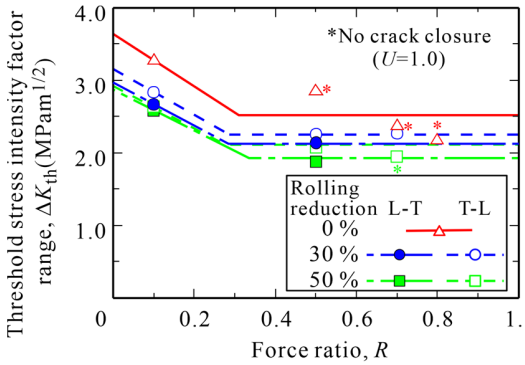
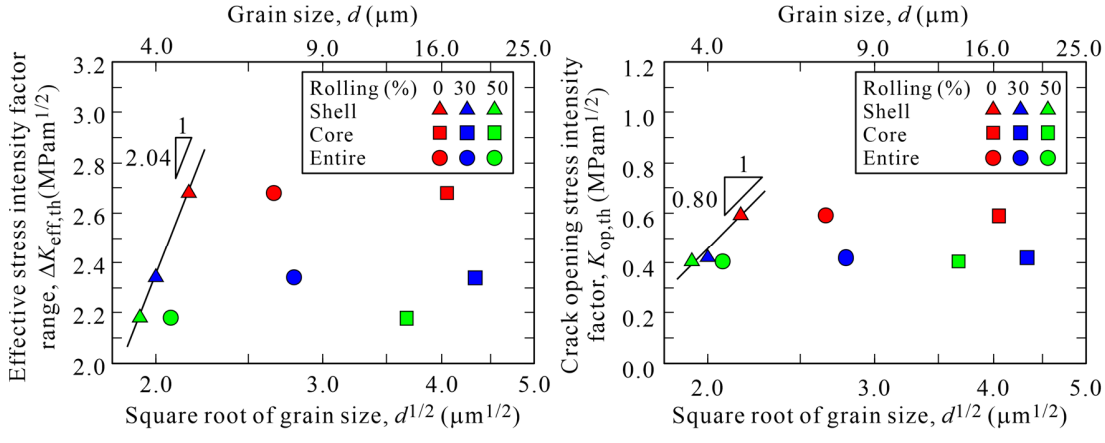


Figure 1. Effect of force ratio on threshold stress intensity factor range.

References:

1) Y. Nakai , S. Kikuchi, K. Osaki, M.O. Kawabata, K. Ameyama, *Int. J. Fatigue*. **2021**, *143*, 106018.



(a) $\Delta K_{eff,th}$ (b) $K_{op,th}$

Figure 2. Effect of grain size on threshold stress intensity factors at R = 0.1.