Effects of twinning deformation on work hardening behavior in commercially pure titanium

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Abstract

To clarify the effect of twinning deformation on the work-hardening behavior of commercially pure titanium, the changes in the grain size and texture due to twinning deformation were investigated, along with the grain-size dependence of the work-hardening behavior. In specimens with an average grain size of 10 μm or less, twinning deformation was inactive, and the instantaneous work-hardening exponent (n = d(lnσ)/d(lnϵ)) was constant at approximately 0.2. For specimens in which twinning deformation occurred, the average grain size decreased and the texture changed with increasing strain due to twinning deformation, which resulted in an increase in the instantaneous n value. In the grain-size range at which twinning deformation did not occur, the smaller the grain size, the higher the rate of increase in the dislocation density and the greater the activity of $\langle$c + a$\rangle$-type dislocations, resulting in an increased work-hardening rate strain hardening rate. Furthermore, the flow stress could be approximated using only the Bailey–Hirsh equation. The promotion of work hardening by twinning deformation can be mostly explained by the increase in the dislocation density increment rate, increase in the fraction of $\langle$c + a$\rangle$ dislocation due to grain refinement, and change in the Taylor factor due to the change in the texture.

Keywords: titanium, twinning, work hardening

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