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Rate-dependent hardening model for HCP metals with effect of deformation twinning and dynamic recrystallization

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ABSTRACT

This paper is concerned with the strain hardening behavior of commercially pure titanium and magnesium alloys for a wide range of strain rates. Pure titanium has described as having three stages of strain hardening behavior during compressive deformation. The stress–strain curve of pure titanium can be divided into three stages according to the strain hardening rate, and the strain hardening rate can be determined by the slope of the stress–strain curve. Mg alloy undergoes the dynamic recrystallization (DRX) during hot working process, which is a restoration or softening mechanism to reduce the dislocation density and release the accumulated energy to facilitate plastic deformation. Even though there are substantial progresses on the establishment in terms of the DRX principles and evolution with the view point of the materials science, an appropriate flow curve modeling for the finite element analysis has been deficient to take into consideration of softening behavior. A novel rate-dependent hardening model is proposed by keeping trace of deformation twins and DRX with increase in the compressive strain, which induces the variation in the strain hardening rate.