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Compatible deformation and ductility of magnesium

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on Mises criterion for compatible deformation is critically revisited, which claims that five independent slip systems have to operate simultaneously in a grain for compatible deformation and five independent slip systems are sufficient to maintain deformation compatibility. For crystals with more than five slip systems, of all possible combinations of slips that can produce the assigned strain, the active combination is determined by the minimum energy dissipation principle (Taylor) or maximum work principle (Bishop & Hill). Crystals with less than 5 independent slip systems cannot deform while maintaining continuity and constant volume. This compatible deformation criterion is established based on the assumption that a single dislocation slip generates a single strain tensor component - since the strain tensor has five independent components in compatible deformation, five independent slip systems are required. Von Mises criterion has been widely accepted since it was put forward in 1928 and consolidated due to further development and modifications by Taylor, Bishop and Hill and many other scientists. However, dislocation slip does not correspond to any particular strain tensor component, which changes under different coordinate systems. Instead, slip is directly related to the relative displacement as plastic deformation is concerned. In this paper, the theoretical flaws and approach errors of this criterion are discussed and a new approach is proposed to account for the requirement of independent slip systems during compatible plastic deformation.

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