

# Criterion for Compatible Deformation of Polycrystalline Materials

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**Abstract.** Von Mises criterion for compatible deformation states that five independent slip systems must operate for polycrystals to deform uniformly and without failure at the grain boundaries, which is supported by Taylor–Bishop–Hill theory or simply Taylor model, defining the laws of plastic deformation of polycrystalline aggregates and being one of the key cornerstones of crystal plasticity theory. However, the criterion is based on an unfounded correlation between phenomenological material flow behaviour in continuum mechanics and dislocation slip, which is crystal structure dependent, and there has been no experimental evidence to show simultaneous operation of five independent slip systems. In this paper, von Mises criterion and Taylor model are revisited and examined critically and the fundamental issues related to the requirement of independent slip systems for compatible deformation and the selection of the active slip systems are addressed. Detailed analysis is performed of stress state that eliminates the possibility of simultaneous operation of five independent slip systems, and of the relative displacement vector due to dislocation slip which defines the quantity of the strain that can be expressed by a strain tensor, instead of individual strain components. Discussions are made to demonstrate that although three linearly independent slip systems are essential sufficient for compatible deformation, one slip system, being selected according to Schmidt law, dominates at a time in a characteristic domain as deformation accommodation occurs between grains or characteristic domains rather than at each point.