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Dislocation Avalanche Polycrystalline Nickel

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ABSTRACT

Self-organized criticality (SOC) is widely observed in systems ranging from creep deformation of single crystal ice to the movement of glacier. -The behavior of these SOC systems follows a power law distribution, which is time- and space-scale invariant. Previous phase field simulation of single crystal nickel has shown that plastic flow is characterized by intermittent dislocation avalanches, which can be characterized by a power law distribution. Does this scale invariance also exist in polycrystalline material, in which dislocation avalanches may be hindered by grain boundaries? In this study, we characterize the dislocation loops using homogenous region division algorithm and investigate the statistics of dislocation loops in polycrystalline nickel with various average grain sizes. We find that plastic flow in polycrystalline nickel consists of dislocation avalanches with sizes over three orders of magnitude. Sudden dislocation bursts are separated by a large amount of small avalanches. This intermittency may bring into question the traditional treatment of plasticity as homogenous process.

KEYWORDS

Dislocation avalanche, self-organized criticality, scale-invariant