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Two-dimensional discrete dislocation dynamics simulation of 316LN discontinuous plastic flow under cryogenic tensile behavior

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Abstract: The serrated yielding (discontinuous plastic flow, DPF) of metallic materials at cryogenic temperatures has always been a research hotspot in the field of plastic deformation of cryogenic-temperature materials, with this topic typically confined to phenomenological theory. This study simulated the cryogenic-temperature dislocation glide and vacancy diffusion by establishing a two-dimensional polycrystalline structure of 316LN within the physical framework of discrete dislocation dynamics (DDD). The dependency relationship between dislocation glide velocity and temperature has been established. The model indicates that the accumulation of dislocations at static obstacles continues to increase below 35K with the decrease of stacking fault energy, which causes the continuous increase in local creep stress until the failure limit is reached. It contributes to the macroscopic stress-strain curve to exhibit discontinuous plastic flow, i.e., serrated yielding.

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