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Scaling of walls in crystals: Deformation, grain boundaries, and dislocation structures YONG CHEN, WOOSONG CHOI, STEFANOS PAPANIKOLAOU, JAMES SETHNA, LASSP, Cornell University — Some experiments of dislocation cell wall structures evolving in deformed metals have observed fractal structures; others have been analyzed in terms of distributions of cell sizes and misorientations that appear non-fractal, but scale with increasing deformation. We analyze a continuum simulation of geometrically necessary dislocations, relaxing in time. In the absence of climb, we observe self-similar (fractal) cell-wall structures, which we exhibit via real-space renormalization group and analyze in terms of critical exponents for correlation functions of dislocation density, orientation, and plastic distortion. For the same simulation, we analyze the distribution of cell sizes and cell wall misorientations, compare to the corresponding experiments, and discuss how our conclusions depend on the application of external loading. In the presence of climb (roughly simulating grain boundary polygonization) we observe non-fractal scaling and polycrystalline behavior.

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