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Phase-Field Crystal Modeling of Polcrystalline Pattern Evolution in Hard and Soft Matter

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The phase-field crystal (PFC) model has attracted considerable attention during the past decade for its potential application to model the complex defect-mediated dynamics of hard and soft crystalline materials on diffusive time scales. The model is rooted in earlier models of non-equilibrium pattern formation (Swift-Hohenberg equation), and classical density functional theory that expresses the free-energy of a system as a functional of its density. This talk will discuss progress made to investigate the dynamics for both isolated grain boundaries and complex polycrystalline patterns under the driving forces of boundary curvature and applied stress. The results highlight fundamental differences between polycrystalline pattern evolution in soft matter, including colloid crystals and crystalline non-equilibrium patterns described by the standard PFC dynamics, and crystalline solids described by a reformulation of this dynamics presented in this talk. The results also pave the way for a unified theory of polycrystalline pattern evolution in hard and soft matter.