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Phase field modeling of liquid metal embrittlement[1] ROBERT SPATSCHEK, NAN WANG, ALAIN KARMA, Physics Dept and CIRCS, Northeastern University — Liquid metal embrittlement (LME) is a phenomenon whereby a liquid metal in contact with another, higher-melting-point polycrystalline metal, rapidly penetrates from the surface along grain boundaries. This phenomenon is known to be greatly accelerated by the application of tensile stress, resulting in the rapid propagation of intergranular cracks in normally ductile materials. Although this phenomenon has been known for a long time, it still lacks a convincing physical explanation. In particular, the relationship of LME to conventional fracture mechanics remains unclear. We investigate LME using a phenomenological three-order-parameter phase field model that describes both the short scale physics of crystal decohesion and macroscopic linear elasticity. The model reproduces expected macroscopic properties for well separated crack surfaces and additionally introduces short scale modifications for liquid layer thicknesses in the nanometric range, which depend on the interfacial and grain boundary energy as well as elastic effects. The results shed light on the relative importance of capillary phenomena and stress in the kinetics of LME.

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