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Elucidating the entropic interaction between fluctuating twin boundaries

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ABSTRACT

Nanotwinned metals have opened up exciting avenues for the design of high-strength, high-ductility materials owing to the extraordinary properties of twin boundaries. The recent advances in the fabrication of nanostructured materials with twin lamella on the order of a mere few atomic layers call for a closer examination of the stability of these structural motifs, especially at high temperatures. In this discussion, we will present a study of the entropic interaction between fluctuating twin boundaries by way of atomistic simulations and statistical mechanics-based analysis. The simulations reveal that for all twin boundary spacings, d, the interaction force between coherent twin boundaries varies as $1/d$. For such crystalline interfaces that are known to exhibit small fluctuations, this long range interaction is rather intriguing albeit consistent with some of the recent studies on the entropic repulsion between fluid membranes. Based on continuum modeling of a fluctuating coherent twin boundary, we discuss the physical underpinnings of this interaction as well as its implications on the stability of nanotwinned metals with ultrahigh density of twins.