KPZ Universality and Anomalous Scaling in the Growth of CdTe Thin Films

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Experimental evidences of systems belonging to the Kardar-Parisi-Zhang (KPZ) class [1] in $d = 2 + 1$ dimensions are very rare, mainly due to the difficult to image two-dimensional interfaces and the consequent poor statistics handled, inherent finite-time/crossover effects in the growth and instabilities caused by mounds/grains at surface that hinder the access to the true asymptotic scaling. Indeed, most of the experimental works on kinetic roughening have been focused only on dynamic exponents from the roughness scaling properties, although universal distributions of heights (HDs), squared roughness (SRDs) and extremal heights (EDs) have been shown to be an alternative and more reliable way for accessing the universality class of a growth process, even when anomalous scaling takes place [2]. In this work, we present a detailed study of the growth dynamics of polycrystalline CdTe thin films on Si(001) substrates at several deposition temperatures (150 - 300 °C). The samples were grown by Hot Wall Epitaxy, a wellcontrolled deposition technique sharing many similarities with the Molecular Beam Epitaxy one. For T = 250 °C, we found scaling exponents in striking agreement with the KPZ ones and the analysis of distributions provided the first experimental confirmation of the universality of KPZ HDs, SRDs and EDs in $d = 2 + 1$ [3]. For samples grown at other temperatures we still finding an asymptotic KPZ scaling. However, for $T < 250$ °C, a random-to-KPZ crossover is found in HDs and SRDs, which have Gaussian (random) and KPZ features at short and long times, respectively. Growth exponents fail in provide the universality class of this system. On the other hand, for $T > 250$ °C, negative skewed KPZ HDs are detected, indicating the existence of some gradient dependent mechanism of refusing particles during the growth. Notwithstanding, we shows that as temperature increases, a transition from “normal” to “inverse” anomalous scaling occurs, owing to changes in grain aspect-ratio, which are corroborated by kinetic Monte Carlo simulations.

References

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