Effects of short-range attachment barriers on submonolayer growth

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Abstract:

A variety of effects can lead to short-range attachment barriers in thin-film growth. While it has been predicted that the exponent which describes the dependence of the island density on deposition rate in the submonolayer regime (where) crosses over from the diffusion-limited value (where is the critical island size) in the absence of an attachment barrier to the attachment-limited value for a strong attachment barrier, this prediction has not been confirmed. Furthermore, the dependence of the effective value of on the barrier strength and ratio (where is the monomer hopping rate) has not been studied. Here we consider the effects of attachment barriers in irreversible growth () for both the case of a barrier to island nucleation and attachment as well as that of an island attachment barrier but no nucleation barrier. Our results indicate that in both cases the effective value of increases with increasing R to a maximum value which depends on barrier strength before decreasing very slowly toward the diffusion-limited value. In addition, both and increase as the barrier strength increases. The results of self-consistent rate-equation calculations are also presented and good agreement is found with our simulations. We also present a scaling analysis for the dependence of on the barrier strength for arbitrary critical island-size and good agreement is found with our simulation results for the case in which there is both a nucleation barrier and a barrier to island attachment.