Phase transition and critical depinning point in two dimensional Frenkel-Kontorova(FK) model

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Abstract:

Based on a 2D Frenkel-Kontorova(FK) model with special square symmetry, the locked-to-sliding phase transition is studied. Two critical depinning points are defined which depend on the direction and the magnitude of external driving force, the adhesive force from the substrate, the interaction strength between atoms in the upper layer and especially the misfit angle θ between two layers. For some certain misfit angle, the friction force is very slow which can quantatively explain the results recently found in experiments(M. Dienwiehel, *et al* Phys. Rev. Lett. **92**, 126101 (2004)). Generally, the phase diagram for this system can be divided into three regions according to the magnitude of the external driving force. The dynamical behaviors of the system and atoms of system are completely different in these three different regions. For the case of misfit angle $\theta = 0^o$, the analytical expressions of two depinning points are obtained and they are in agreement with numerical ones. For the case of $\theta \neq 0^o$, it is numerically found that two depinning points are in fractal structure.

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