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# Vacancy-Induced Changes in the Surface Morphology During the Growth of Ag on Ag(111)

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Beamline(s): X3B2

X-ray scattering studies of homoepitaxial growth on Ag(111) show that vacancies, which are incorporated during growth at low temperature, cause changes in the surface morphology. Typically, the fluctuations of the surface height are well described by a Poisson distribution, leading to the monotonic decay of the x-ray reflectivity observed in experiments [1] on Ag(111) at higher temperature. However, as seen in Fig.1 for 100 K, thin-film interference fringes are observed at the low angle reflectivity, suggesting a bimodal character of the terrace height distribution. These data are well described by pyramid-like structures at the surface, leading to the non-Poisson height distribution shown in Fig. 2. The present x-ray data suggest that the surface mounds, which are normally expected to be present [2,3], have their height distribution altered by the vacancies.

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References:

[1] W. C. Elliott, P. F. Miceli, T. Tse, and P. W. Stephens, “Temperature and Orientation Dependence of Kinetic Roughening During Homoepitaxy: A Quantitative X-ray Scattering Study of Ag”, Physical Review B, **54**, 17938 (1996).

[2] W. C. Elliott, P. F. Miceli, T. Tse, and P. W. Stephens, “Kinetic Roughening During Homoepitaxy”, in *Surface Diffusion: Atomic and Collective Processes*, ed. M. Tringides, NATO-ASI Series B (Plenum Press, 1997), p.209.

[3] M.C. Bartelt and J.W. Evans, "Transition to Multilayer Kinetic Roughening for Metal (001) Homoepitaxy," Physical Review Letters, **75**, *4250,* 1995.

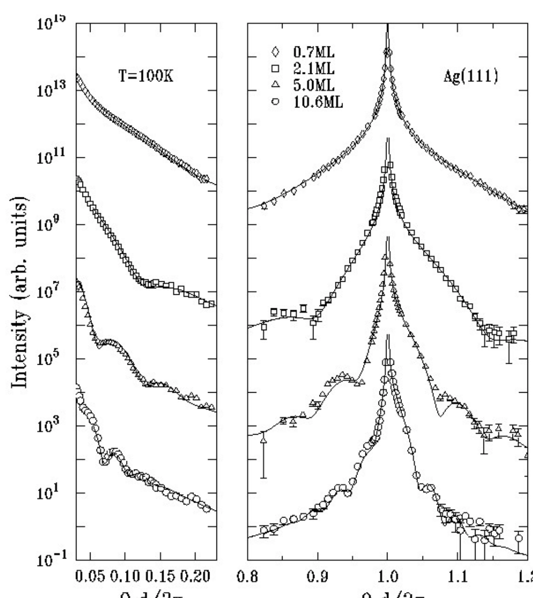


**Figure 1**. Measured reflectivity from 0.7ML (diamonds), 2.1ML (squares) 5.0ML (triangles) and 10.6ML (circles), deposited on “clean” Ag(111) surfaces at T=100K. The curves are vertically shifted for clarity. The best fits (solid lines) are based on a model where, in addition to the surface-normal strain arising from vacancies in the deposited films, a surface morphology consisting of pyramid-like structures with uniform heights is assumed. This latter feature gives rise to the thin film interference fringes observed in the low-angle reflectivity.

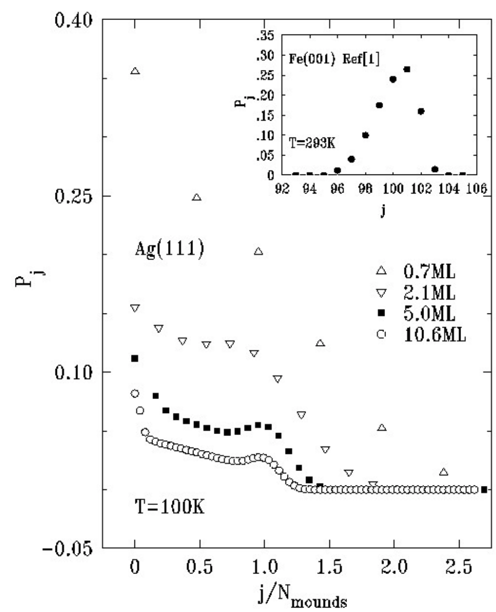


**Figure 2**. The fraction of the exposed surface atoms, $P_j$, as a function of their height level $j$, is obtained from the fits in Fig.1 and shown for different coverages. It is this particular distribution of terrace heights, and not the mere presence of mounds, that makes the film’s average density distinguishable from that of the substrate, leading to the appearance of fringes in the low-$Q_z$ reflectivity. The skewed Gaussian obtained in simulations [3] and shown in the inset, does not lead to asymmetries or fringes in the reflectivity profile, although, well developed mounds are present.