Growth of Al nanocrystals on the decagonal surface of the Al-Co-Ni quasicrystal

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The interfacial lattice mismatch of periodic films and quasiperiodic substrates leads to self-size-selecting growth of nanocrystals. The orientation of these nanocrystals is strongly affected by the symmetry of the quasicrystalline substrate [1].

We have studied the growth of Al on the decagonal surface of the Al-Co-Ni quasicrystal at room temperature using a deposition rate of 0.8 Å/min. For film thicknesses of 4–150 Å low-energy electron diffraction and secondary-electron imaging reveal the formation of Al nanocrystals in their native fcc structure. Two sets of ten domains with the (111) face parallel to the decagonal surface evolve. Within each set, the domains are rotated by 36° azimuthal increments, while the two sets are displaced by approximately 2.5° to each other.

In order to account for these observations we have performed simulations using both a rigid-lattice atomic model based on an adapted Lennard-Jones potential for the adsorbate-substrate interaction and a molecular-dynamics model with a varying interaction between adatoms. We find that Al nucleation occurs inhomogeneously at specific substrate sites around which the local rotational substrate symmetry is tenfold. Furthermore, the observed twinning is reproduced by increasing the interaction between adatoms compared to the adsorbate-substrate interaction [2].

References:

[1] see, e. g., B. Bolliger, V.E. Dmitrienko, M. Erbudak, R. Lüscher, and H.-U. Nissen, Phys. Rev. B **63**, 052203 (2001); V. Fournée, T.C. Cai, A.R. Ross, T.A. Lograsso, J.W. Evans, and P.A. Thiel, Phys. Rev. B **67**, 033406 (2003).

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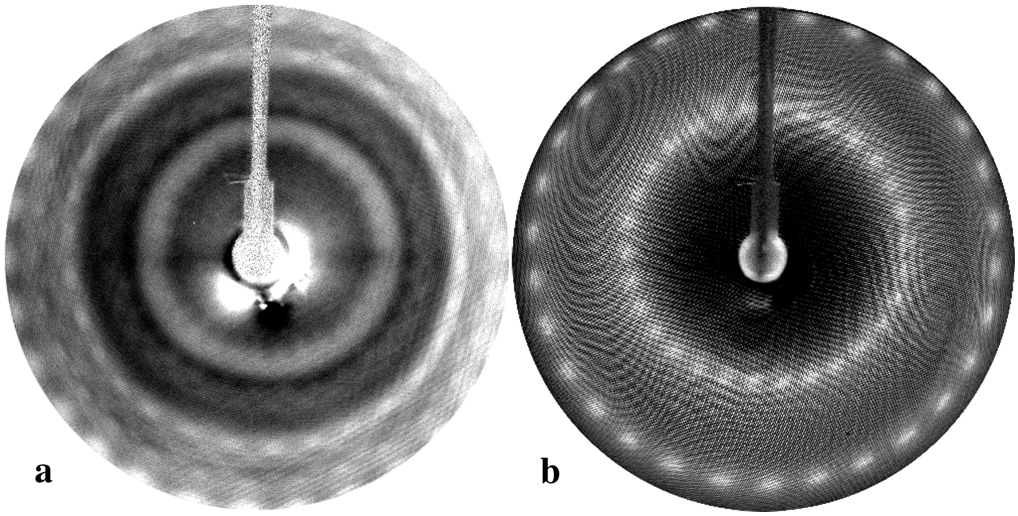

(a) Secondary-electron image at 2 keV and (b) LEED pattern at 142 eV obtained at normal incidence from a 150-Å thick Al film deposited onto the decagonal surface of Al-Co-Ni.