Quasicrystals: Intellectual Beauty and Physical Opportunities

Patricia A. Thiel

Ames Laboratory, and Departments of Chemistry
and Materials Science & Engineering
Iowa State University
Ames, IA 50011 USA

Quasicrystals are metallic alloys in which the atoms exhibit a remarkable arrangement: They are well-ordered, but not in a periodic fashion. Even more interesting, these materials exhibit unusual combinations of physical properties—apparently linked to their atomic structure. The opportunity to use these materials as templates for growth is the topic of this talk.

Specifically, we have studied metals deposited on quasicrystalline substrates in order to derive fundamental physical insights into the processes and energetics involved in formation of an aperiodic-periodic interface. In this talk, I will provide examples of three main types of information, which can be obtained from different coverage (thickness) regimes. With increasing coverage, they are: (i) nucleation; (ii) growth modes, reflecting surface and interface energies; and (iii) crystallographic orientations—specifically, relationships between high-symmetry zone axes of the quasicrystal and the thick crystalline film. To derive these types of information, we have measured film structures of Ag and Al, as probe metals, on a number of different substrates, including Al(111), the ξ’ Al-Pd-Mn approximant, the fivefold surface of icosahedral Al-Pd-Mn, and the tenfold surface of decagonal Al-Ni-Co. Our observations include site-specific “heterogeneous” nucleation on the fivefold quasicrystalline surfaces; strong differences in growth modes for film-surface couples that are chemically similar; and interfacial crystallographic alignments that are different than those reported commonly for confined (bulk) interfaces. Where possible, comparisons are made between these observations, and those typical of single-element metal homoepitaxy.

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