Ordered oxide layers on decagonal Al-Co-Ni and icosahedral Al-Pd-Mn quasicrystals

M. Erbudak$^{1,2}$ and S. Burkardt$^1$

$^1$Laboratorium für Festkörperphysik, ETH Zurich, CH-8093 Zurich and

$^2$Boğaziçi University, 34342 Bebek, TR-Istanbul

Abstract

Metal oxides display a variety of crystal structures which often are more complicated compared to the parent metals [1]. In particular, the oxide structures grown on ordered aluminum binary alloys have been an immense challenge for scientists since decades [2]. On NiAl(110), oxygen binds to Al and forms an atomically thin layer of super-cell epitaxy with a huge unit cell. We investigate the structure of oxide layers grown on decagonal and icosahedral quasicrystal surfaces at elevated temperatures. The oxide structure on these surfaces are even more complicated because the substrate, being a quasicrystal, lacks periodicity, even though long-range orientational order exists. We find that the structural mismatch at the crystal-quasicrystal interface leads to self-size selected aluminum-oxide islands with a diameter of typically $3 - 4$ nm, similar to the growth of metallic matter on quasicrystals [3,4]. Electron diffraction experiments show that on the decagonal surface of Al-Ni-Co, the individual oxide islands located within the electron coherence length interact, and the diffraction pattern show characteristic anti-phase boundary structures. On the pentagonal surface of Al-Pd-Mn, on the other hand, the oxide islands show a $3 \times 2\sqrt{3} - R 30^\circ$ superstructure which is 12 times larger than the unreconstructed hexagonal Al$_2$O$_3$ structure. We emphasize the possibility of using these well-ordered islands as substrates for generating quantum-well structures.