Optical and electrical properties of polycrystalline and amorphous Al-Ti thin films

The structural, optical, and transport properties of sputter-deposited Al-Ti thin films have been investigated as a function of Ti alloying with a concentration ranging from 2% to 46%. The optical reflectivity of Al-Ti films at visible and near-infrared wavelengths decreases with increasing Ti content. X-ray absorption fine structure measurements reveal that the atomic ordering around Ti atoms increases with increasing Ti content up to 20% and then decreases as a result of a transition from a polycrystalline to amorphous structure. The transport properties of the Al-Ti films are influenced by electron scattering at the grain boundaries in the case of polycrystalline films and static defects, such as antisite effects and vacancies in the case of the amorphous alloys. The combination of Ti having a real refractive index (n) comparable with the extinction coefficient (k) and Al with n much smaller than k allows us to explore the parameter space for the free-electron behavior in transition metal-Al alloys. The free electron model, applied for the polycrystalline Al-Ti films with Ti content up to 20%, leads to an optical reflectance at near infrared wavelengths that scales linearly with the square root of the electrical resistivity.