Thickness Dependent Magnetism of Pd(100) Thin Film

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Ferromagnetism appears in (100) facets of Pd nanoparticle although bulk Pd is nonmagnetic [1]. Many calculations predicted that Pd(100) thin films have the spontaneous magnetization and the magnetic moment oscillates dependent on thickness of films. This can be interpreted in terms of quantum confinement effect [2]. In this study, we experimentally investigate the magnetism of Pd(100) thin films as a function of thickness.

Pd(100) thin films with 15 ~ 25 monolayers (MLs), which are encapsulated in quartz tubes to prevent gas adsorption, show ferromagnetism and the spontaneous magnetizations show oscillatory behavior with film thickness, although the 50 ML film shows no spontaneous magnetization (Fig. 1). The magnetic moment of ferromagnetic films ranges from 0.05 to 0.6 μB/atom. This indicates that the discrete electronic states shift to Fermi energy to satisfy the condition for ferromagnetism (Stoner criterion) at a specific film thickness, as theoretically expected from two-dimensional quantum confinement in Pd(100) thin films. In addition, the adsorption of air and H₂ gas causes the reduction of spontaneous magnetization through the change in electronic state (Fig. 2). This indicates that the spin polarization appears over the entire Pd film as predicted from our recent study [3].