

## SUMMARY OF Ph.D. DISSERTATION

School Integrated Design Engineering	Student Identification Number	SURNAME, First name SHINOHARA, Takenao
Title  Magnetic properties appearing on the surface of Pd fine particles		
Abstract <p>The physical properties of nano-scale materials are different from that of bulk. One of the interesting issues is the appearance of ferromagnetism in low-dimensional systems in metallic materials, which are nonmagnetic in bulk size. The clean particle surface is suitable for studying this phenomenon, because it is an ideal low-dimensional system free from the effects of any surroundings, such as substrate of thin film. Furthermore the possibility of controlling the magnetism of the particle surface, which is very sensitive to the molecule adsorption, is important for applying to magnetic devices. However the details of magnetic properties or magnetic ordering appearing on the surface of the fine particles have not been clarified yet.</p> <p>In this study, magnetic properties of Pd fine particles with clean surface were investigated, and the appearance of ferromagnetism in the surface of Pd fine particles was verified. To clarify the mechanism of surface ferromagnetism, the gas adsorption experiments of Pd fine particles were performed. In addition, dilutely Fe-doped Pd fine particles were studied by means of magnetization measurements and the X-ray magnetic circular dichroism. The content of each chapter is below.</p> <p>Chapter 1 summarizes the background of this study and the advantage of studying surface magnetism of fine particle system.</p> <p>Chapter 2 describes the theories of the itinerant electron magnetism and the results of previous studies on the magnetic properties of low-dimensional 4d transition metals.</p> <p>Chapter 3 describes the magnetic properties and the structure of gas-evaporated free-standing Pd fine particles with very clean surface. The appearance of ferromagnetism in Pd fine particles was confirmed directly by magnetization measurements. The size dependences of magnetization and particle structure reveal that the ferromagnetism of Pd fine particles occurs only at (100) facets, and that the magnetic moment per Pd atom is <math>0.75 \pm 0.31 \mu_B</math>. A drastic decrease in magnetization, caused by a small amount of O<sub>2</sub> gas adsorption on the particle surface, indicates that the ferromagnetism has its origin in the electronic structure of the surface, which is sensitively affected by the gas adsorption.</p> <p>Chapter 4 describes the results of magnetization measurements performed on dilutely Fe doped Pd fine particles. The size dependence of magnetization suggests that the fine particle consists of ferromagnetic core and the surface shell with relatively small magnetization. The transition temperature of surface shell was lower than that of particle core.</p> <p>Chapter 5 describes the magnetic polarization of Pd in PdFe fine particles studied by the X-ray magnetic circular dichroism. The magnetic moment of Pd atom was mainly attributed to the spin moment, and showed no size dependence. This indicates that the size dependent magnetization of PdFe fine particles was explained by the decrease of the Fe magnetic moment.</p> <p>Chapter 6 summarizes the results of this study.</p>		