Summary of Doctoral Thesis

Title of Doctoral Thesis: Growth and magnetism of epitaxial Fe nanofilms on ammonia-terminated and three-dimensionally structuralized Si{111} surfaces

Name: Liliany Noviyanty Pamasi

Summary of Doctoral Thesis:

The epitaxial growth and magnetic properties of ferromagnetic transition metal film on Si substrate are one of the attractive surfaces and interface subjects due to their importance in fundamental research and application such as in spintronic devices. Therefore, profound studies of this subject need to be explored.

In this dissertation, author mainly focus on the research of the growth of the ultra-thin films of Fe ferromagnetic metals and their silicon compounds on structurally modified Si substrate surfaces. Author established an electron diffraction analysis methodology to control the high-quality film growth. In addition, by the extension of the film-growth substrate from two-dimensional (2D) planar base to three-dimensional (3D) solid shape, author revealed amazing magnetic behaviors originated from the vortex motion on precisely created nano-meter films with 3D shape. These topics are described in chapters 2-5.

In Chapter 2, author have successfully controlled the shape and crystallinity of Fe(111) metal film islands on atomically-flat Si(111) surfaces with 7×7 superstructures, utilizing precise surface treatments and electron diffraction measurements for in-situ growth with spot-analysis methods. Author have definitely increased the in-plane crystallinity of the grown Fe islands and observed the magnetic properties which show the pinning effect arose from the gaps or amorphous Fe island between Fe crystalline island on the ammonia-saturated surface (Chapter 3). In the future, molecules are promising to use as the domain wall pinning to fine-tuning the magnetization reversal process. Furthermore, author successfully created epitaxial Fe films on atomically-flat facet surfaces of 3D fabricated pyramid microstructures (Chapter 4) and revealed the peculiar ferromagnetic properties of pyramidal Fe nano films originated from the vortex motion reflecting the 3D shape effect (Chapter 5). These results will lead to future designation for magnetic vortex, i.e., the control of spin orientation in space utilizing characteristic 3D shaped ferromagnetic films.

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Summary of Thesis Examination Results:

The epitaxial growth and magnetic properties of ferromagnetic transition metal film on Si substrate are one of the attractive surfaces and interface subjects due to their importance in fundamental research and application such as in spintronic devices. The author mainly focuses on the research of the growth of the ultra-thin films of Fe ferromagnetic metals and their silicon compounds on structurally modified Si substrate surfaces.

At first, the author has successfully controlled the shape and crystallinity of Fe(111) metal film islands on atomically-flat Si(111) surfaces with 7×7 superstructures, utilizing precise surface treatments and electron diffraction measurements for in-situ growth with spot-analysis methods. At this time, the author has established an electron diffraction analysis methodology to control the high-quality film growth. The author has definitely increased the in-plane crystallinity of the grown Fe islands and observed the magnetic properties which show the pinning effect arose from the gaps or amorphous Fe island between Fe crystalline island on the ammonia-saturated surface. In the future, molecules are promising to use as the domain wall pinning to fine-tuning the magnetization reversal process. Secondly, the author successfully created epitaxial Fe films on atomically-flat facet surfaces of 3D fabricated pyramid microstructures and revealed the peculiar ferromagnetic properties of pyramidal Fe nanofilms originated from the vortex motion reflecting the 3D shape effect. These results will lead to future designation for magnetic vortex, i.e., the control of spin orientation in space utilizing characteristic 3D shaped ferromagnetic films.

As described above this thesis has revealed a new control method of Fe(111) metal film islands on Si(111) using ammonia, and magnetic properties of Fe films on 3D fabricated pyramid microstructures. Because this knowledge is fundamentally important to the basic science of nanomaterial creation, the committee agreed that this thesis is worth as a Ph.D. thesis for a Doctor of Engineering.