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Research field: Surface & Interface Physics

Outline and goals of current research

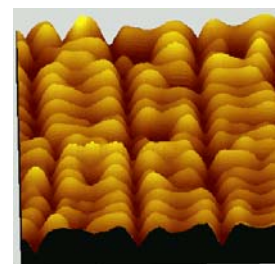
Our research is aimed at understanding and controlling the nano-structures and their electrical properties at surfaces and interfaces. We use the physical and chemical characteristic properties of surfaces/interfaces to build nano-size structures with specific types of electronic states and functionality. Our research field is from basic research of the surface/interface nano-structures and their specific electronic states like quantum confinement by using state-of-art experimental techniques to development of quantum mechanical functions of nanostructured materials.

Research topics conducted within the G-COE project

1. One-dimensional quantum well arrays on Ge/Si(001) surfaces

At surfaces of epitaxially grown germanium wetting layer on silicon(001) substrate, one-dimensional dimer chains are segmented into atomic chains of ~ 10 atoms in length with dimer vacancy lines (DVLs). Each chain confines surface electrons and reveal one-dimensional quantum well nature. On the Ge/Si(001) surfaces, the one-dimensional quantum wells aligned with ultra-high density.

In this project, we try to introduce mutual interaction between neighboring quantum wells, and functionalize this ultra-high density one-dimensional quantum well system at Ge/Si(001) surfaces.



A STM image of the spatial distribution of $n=2$ quantum well states on the one-dimensional dimer chain segments aligned at the Ge/Si(001) surface.

2. Wave function engineering at Ag/Si(111) surfaces

We study the formation of atomically flat Ag films of nano-thickness by quantum-driven Electronic growth, one-dimensional quantum confinement of Ag sp-band electrons along surface normal direction and their application to quantum catalyst, artificial design and construction of two-dimensional quantum structures with arbitrary shape and size at Ag/Si(111) surfaces.

Representative publications

- H.Hirayama, "Size control of Nanostructures by Quantum Confinement" Chap.7 in *Nanomaterials from Research To Applications*, eds. H.Hosono, Y.Mishima, H.Takezoe, K.J.D.Mackenzie, Elsevier Amsterdam, 2006
M.Watai & H.Hirayama, "Resonant optical second harmonic generation from quantum-well states in Ag films on Si(111)7x7 surfaces, *Physical Review B* 72,085435(2005)

Research topics suitable for joint research

1. Growth of atomically flat films by Electronic growth technique.