

Two talks in the afternoon of July 29<sup>th</sup>, 2009: Dr.s Manabu Ishimaru and Kazuhisa Sato  
Wilsdorf Hall, Room 101 Starting 2:30 ( Dr. Ishimaru) and 3:20 (Dr. Sato)

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**Naturally-formed nanostructures in III-V  
semiconductor alloys**

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There exists a formidable challenge to integrate low-dimensional nanostructures, such as quantum dots and nanowires, in semiconductor materials, because they can add novel physical properties to functional devices. Lateral composition modulation (LCM), which is defined as the formation of phase-separated, periodic structures perpendicular to the growth direction, is one of the examples of naturally-formed vertical quantum wells, and extensive studies have been performed to integrate this structure into III-V semiconductor alloys. Currently, the lateral modulation period of 10-50 nm is achieved by utilizing a short-period superlattice in which strain field during epitaxial growth plays an important role for the formation of LCM. Here, we demonstrate that highly-arranged LCM with a wavelength of ~1 nm can be naturally formed by spontaneous phase separation during epitaxial growth of TlGaInAsN [1]. We discuss its formation process using a simple kinetic Ising model for layer-by-layer growth of III-V epilayers [2], and point out that the formation of ultra-short period LCM is a universal phenomenon in most of epitaxially-grown III-V semiconductor alloys.

[1] M. Ishimaru *et al.*, Appl. Phys. Lett. **94**, 153103 (2009).

[2] M. Ishimaru *et al.*, Phys. Rev. B **51**, 9707 (1995); **52**, 5154 (1995); **54**, 10814 (1996); J. Appl. Phys. **77**, 2370 (1995).

**Atomic structure imaging of FePd nanoparticles by  
C<sub>s</sub>-corrected HRTEM and HAADF-STEM**

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Nanoparticles of FePd alloy with the L1<sub>0</sub>-type ordered structure is one of the candidates for future ultra-high density magnetic storage media. A key issue in such a hard magnetic property is the long-range order inside a small nanoparticle. In this study, we employed C<sub>s</sub>-corrected HRTEM and HAADF-STEM for atomic structure imaging of the ordered alloy nanoparticles (FEI Titan 80-300 / JEOL JEM-2200FS). HRTEM clearly resolves the periodic arrangement of atoms due to atomic order as bright contrast under a small negative C<sub>s</sub> value. The faceted particle interface is imaged without contrast delocalization by means of a small defocus nearly corresponding to the Gaussian focus. A clear-cut long-range order is lost when particle size is smaller than about 5 nm, and locally ordered particles begin to dominate, indicating the instability of the ordered phase. The Z-contrast allows a clear observation of the alternate stacking of Fe and Pd in small nanoparticles. In particular, the results revealed complex structures at an intermediate stage of the ordering process with ordered regions of both L1<sub>0</sub> and L1<sub>2</sub> phases. This talk will describe our recent results on electron tomography using ADF-STEM.