The 250th MANA Seminar

Graphene edges; its unconventional electronic structure and the origin of activities in graphene

Chair: Dr. Masakazu Aono (MANA Director-General)

Prof. Toshiaki Enoki

(Department of Chemistry, Tokyo Institute of Technology, Japan)

When a graphene sheet is cut into fragments, the created edges affect seriously the electronic structure depending on the edge shape (zigzag and armchair edges) as observed with the electron wave interference and the creation of spin-polarized non-bonding edge state. We investigated the edge-inherent electronic features of graphene by STM/STS, AFM observations, NEXAFS, Raman spectra, ESR and magnetic susceptibility. STM/STS and NEXAFS observations of graphene edges demonstrate the presence of edge states in zigzag edges in spite of the absence of such state in armchair edges. In the vicinity of an armchair edge, a hexagonal pattern was observed together with a 3-fold symmetry fine structure at the individual superlattice spots. This is understood as a consequence of the K-K' intervallery scattering with interference taking place at an armchair edge. The 3-fold symmetry fine structure suggests the antibonding coupling between the adjacent spots in the hexagonal superlattice. The intervalley scattering at an armchair edge gives specific dependence of the Raman G-band intensity on the polarization direction of the incident laser beam as expressed by $\cos^2 \Theta$ (Θ; the polarization angle). A graphene nanoribbon of 8 nm >1 μm prepared by heat-treatment of graphite step edges shows this angular dependence, being demonstrated to consist of pure armchair edges. Single sheet graphene oxide is found to form a 2D arrangement of linear corrugations of oxidized lines running along the zigzag direction with an interline spacing of ca.10 nm. This suggests that zigzag edged graphene nanoribbons with a width of ca.5 nm are created between the oxidized lines. Nanofabrication by an AFM tip can allow us to create a nanostructure of graphene sheet intentionally.

Venue: Seminar Room #431, 4F, MANA Bldg.,

Date: February 24th, Friday **Time:** 15:30-16:30

Namiki site

Contact: International Center for Materials Nanoarchitectonics (MANA), Nakata (ex. 8806)