Advanced Research Center for Beam Science
- Electron Microscopy and Crystal Chemistry -

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Visitors

Prof CHOU, Li-Jen	National Tsing-Hua University, Taiwan, 1 September 2005–30 April 2006
Prof GAUVIN, Raynald	McGill University, Canada, 23 August 2006
Prof KRIVANEK, Ondrej	Nion, USA, 11 September 2006
Prof MILES, Mervyn John	University of Bristol, UK, 12 September 2006
Prof LIN, King-Fu	National Taiwan University, Republic of China, 2 June 2006

Scope of Research

Crystallographic and electronic structures of materials and their transformations are studied through direct imaging of atoms or molecules by high-resolution spectromicroscopy which realizes energy-filtered imaging and electron energy-loss spectroscopy as well as high resolution imaging. It aims to explore new methods for imaging and also obtaining chemical information in thin films, nano-clusters, interfaces, and even in solutions. By combining this with scanning probe microscopy, the following subjects are urging: direct structure analysis, electron crystallographic analysis, epitaxial growth of molecules, structure formation in solutions, fabrication of low-dimensional functional assemblies.

Research Activities (Year 2006)

Presentations

Interpretation of Electron Energy-Loss Near-Edge Structure by First Priciples Band Structure Calculation, Kurata H, Tsujimoto M, Nemoto T, Isoda S, The 3rd Japan-China Joint Seminar on Atomic Level Characterization, 6–10 March, Xiamen, China.

STM and STS Study on Platinum Chains in Bis(1,2-benzoquinonedioximato)platinum, Yaji T, Yoshida K, Tsujimoto M, et al., IMC16, 3–8 September, Sapporo, Japan.

Atomic Resolution HAADF-STEM Analysis of Layered Double Perovskites La_2CuSnO_6, Haruta M, Masuno A, Kan D, et al., IMC16, 3–8 September, Sapporo, Japan.

Development of Cold-FEG with a Nanotip for 200kV TEM/STEM, Kurata H, Isoda S, Tomita T (JAERI), IMC16, 3–8 September, Sapporo, Japan.

Temperature and Electric Field Dependences of the Mobility of a Single-grain Pentacene Field-effect Transis-

Topics

Nanodiffraction and Characterization of Titanate Nanotube Prepared by Hydrothermal Method

Titanate nanotubes have been of great interest recently due to their potential application to dye sensitized solar cells, gas sensors and photocatalysts (Figure 1). Though the nanotubes are widely believed to be formed by rolling up sheet-like precursors, their detailed formation mechanism and crystal structure have been still under discussion. Therefore, we carefully investigated the local structure of a single nanotube as well as its co-product by using electron nanodiffraction technique. Titanate nanotubes were synthesized by a simple hydrothermal treatment of TiO_2 anatase powders. To observe the change of the diffraction pattern in the different small area, we focused a parallel electron probe as small as 1 nm in diameter and moved it across the nanotube (Figure 2). Our detailed local observations via electron nanodiffraction strongly suggest that the nanotubes are formed by rolling up the exfoliated lepidocrocite-type titanate sheet along the [100] direction without helicity.

Temperature and Electric-field Dependence of the Mobility of a Single-grain Pentacene Field-effect Transistor

A single-grain organic field-effect transistor (OFET) of pentacene with a 1 μm channel length of top-contact electrodes is demonstrated in a wide range of temperatures from 300 down to 5.8 K (Figure 3). No hysteresis behavior was observed in the transfer characteristics throughout the entire temperature range. The saturation mobility and on/off ratio are estimated as 1.11 cm^2/Vs and 10^7 at 300 K and 0.34 cm^2/Vs and 10^5 at 5.8 K, respectively. The non-monotonic temperature dependence of the mobility indicates a bandlike transport at high temperatures. The electric-field dependence of the mobility in the single-grain OFET does not show a Poole-Frenkel-like behavior. This indicates that Poole-Frenkel-like behavior observed in conventional OFETs can be attributed to the disorder of molecules; single-grain OFET is free from such disorders.

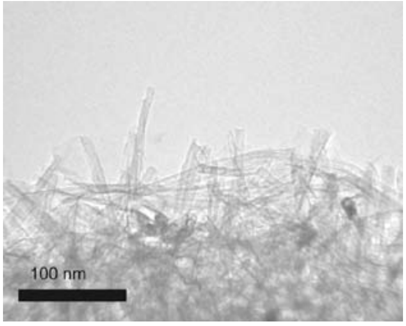

Figure 1. Typical TEM images of titanate nanotubes.

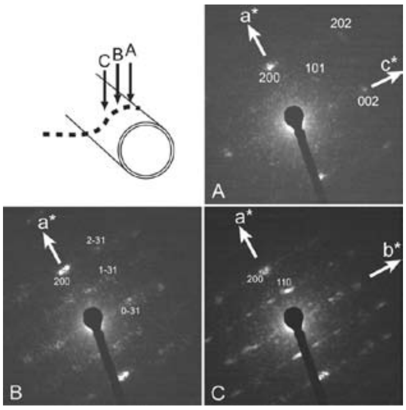

Figure 2. The incident electron beam was moved across the nanotubes from the center (A) to the side (C) of one nanotube.

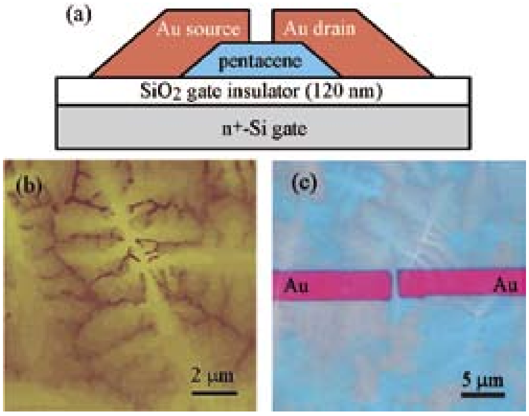

Figure 3. (a) Schematic cross section of a single-grain OFET with top-contact structure. (b) Morphology of vacuum-deposited pentacene film observed with an AFM. (c) Optical microscope image around a channel region of a single-grain OFET with 1 μm of channel length.

tor, Minari T, Nemoto T, Isoda S, Intern. Forum on Green Chem. Sci. & Eng. and Process Systems Engineering, 8–10 October, Tianjin, China.

Iron Oxides Nanostructure; Growth, Characterization and Applications, Chou L J, Lai M W (NTHU) et al., Nabisconference, 8–9 August 2006, Chicago, USA.

Grants

Kurata H, Development of an EELS/XES Electron Microscope for Electronic Structure Analysis, Leading Project, The Ministry of Education, Science, Culture and Sports, Japan, 1 April 2004–31 March 2007.

Kurata H, Local State Analysis of Organic Materials by Spatially and Angular Resolved EELS, Grant-in-Aid for Scientific Research (B), 1 April 2003–31 March 2006.

Isoda S, Nanotechnology Support Project, The Ministry of Education, Science, Culture and Sports, Japan, 1 April 2006–31 March 2007.