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Author(s)	
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Advanced Research Center for Beam Science
– Electron Microscopy and Crystal Chemistry –

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Assoc Prof
KURATA, Hiroki
(D Sc)

Assist Prof
OGAWA, Tetsuya
(D Sc)

Assist Prof
NEMOTO, Takashi
(D Sc)

Res
MORIGUCHI, Sakumi
(D Sc)

Res*
HARUTA, Mitsutaka
(D Sc)

* Industry-Goverment-Academia Collaboration

Guest Res Assoc
CHOMSAENG, Natthaphol

Students

MIYAMOTO, Yusuke (RF)
KIYOMURA, Tsutomu (D3)
SHINODA, Yasuhiro (D2)
OMORI, Yuuki (M2)
SAITO, Hikaru (M2)
ASO, Ryotaro (M2)
KARIYA, Ayuta (M2)
UMEMURA, Kayo (M1)

Visitors

Prof VALMALETTE, Jean-Christophe	Université du Sud Toulon Var, France, 19 February
Prof CHAIRUANGSRI, Torranin	Chiang Mai University, Thailand, 15–31 March
Prof Em EGERTON, Raymond F.	University of Alberta, Canada, 5 April
Dr LO, Shen-Chuan	Industrial Technology Research Institute, Taiwan, 26–29 April
Dr CHEN, Shih-Yun	National Taiwan University of Science and Technology, Taiwan, 20 July
Dr GLOTER, Alexandre	Laboratoire de Physique des Solides (CNRS), France, 23 August
Dr LAI, Ming-Wei	Industrial Technology Research Institute, Taiwan, 6–9 September

Scope of Research

Crystallographic and electronic structures of materials and their transformations are studied through direct imaging of atoms or molecules by high-resolution electron spectromicroscopy which realizes energy-filtered imaging and electron energy-loss spectroscopy as well as high resolution imaging. 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, and fabrication of low-dimensional functional assemblies.

KEYWORDS

TEM
STEM
Cryo-TEM
EELS
SPM

Selected Publications

Kobayashi T, Ogawa T, Moriguchi S, Suga T, Yoshida K, Kurata H, Isoda S: Inhomogeneous Substitution of Polyhalogenated Copper-phthalocyanine Studied by High-resolution Imaging and Electron Crystallography, *J. Electron Microsc.*, **52,** 85-90 (2003).
Minari T, Nemoto T, Isoda S: Temperature and Electric-field Dependence of the Mobility of a Single-grain Pentacene Field-effect Transistor, *J. Appl. Phys.*, **99,** 034506 (2006).
Kiyomura T, Nemoto T, Ogawa T, Minari T, Yoshida K, Kurata H, Isoda S: Thin-Film Phase of Pentacene Film Formed on KCl by Vacuum Deposition, *Jpn. J. Appl. Phys.*, **45,** 401-404 (2006).
Haruta M, Yoshida K, Kurata H, Isoda S: Atomic Resolution ADF-STEM Imaging of Organic Molecular Crystal of Haloganated-Cu-phthalocyanine, *Ultramicroscopy*, **108,** 545-551 (2008).
Haruta M, Kurata H, Komatsu H, Shimakawa Y, Isoda S: Site-resolved Oxygen K-edge ELNES of Layered Double Perovskite La_2CuSnO_6, *Physical Review B*, **80,** 165123 (2009).

Topics

HRTEM and ADF-STEM of Precipitates in Aluminium Alloy

Precipitates at peak-ageing in an A356 Al–Mg–Si alloy cast by a semi-solid process have been studied by high-resolution transmission electron microscopy (HRTEM) and annular dark-field scanning transmission electron microscopy (ADF-STEM). The precipitate most frequently found in the alloy is the β” phase (Mg_5Si_6) or its precursors. Although the contrast of ADF image, especially HAADF, an atom with a higher atomic number should show a brighter contrast comparing to one with a lower atomic number (Z-contrast), the precipitate shows the darker contrast as compared to that of the Al matrix in High Angle ADF-STEM (HAADF-STEM), and vice versa in Low Angle ADF-STEM (LAADF-STEM). To understand such contrast, a dynamical simulation based on the multi-slice method was performed using different atomic stacking models; the precipitate layer is located at the top (I), bottom (II) or middle (III) of the sample. Model (III), where the precipitate situates inside the Al matrix, successfully explained the reverse contrast of the experimental images of the precipitate. The origin of such a strange contrast variation comes from the dynamical and the channeling effects in the crystalline precipitate situated in a crystalline matrix, of which the dynamical simulation is indispensable in structure analysis. The LAADF-STEM is a potential tool in atomic structure analysis of precipitates in combination with HAADF-STEM.

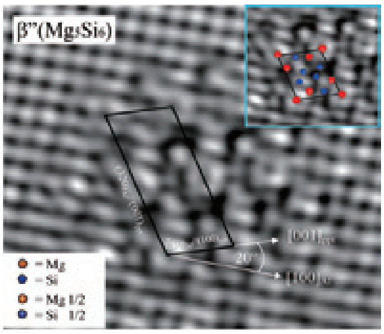

Figure 1. Noise-filtered HRTEM image of the precipitate.

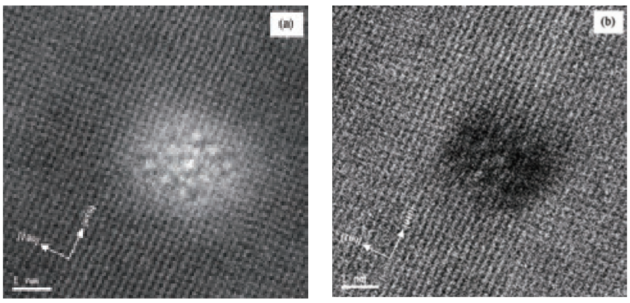

Figure 2. LAADF (a) and HAADF (b) images of the same precipitate.

Gelation Behavior by the Lanthanoid Adsorption of the Cyanobacterial Extracellular Polysaccharide Sacran

Cyanobacteria, which live in the rivers and sea where industrial waste is discharged, produce and secrete polysaccharides with functional groups such as carboxylic acid, sulfates, phosphates and amines that are responsible for ionic adsorption. These extracellular polysaccharides adsorb heavy metal ions in the water to prevent toxicity, and protect the cells themselves. The self-organization behavior of an extracellular polysaccharide (sacran) extracted from the cyanobacterium Aphanothece sacrum in response to lanthanoid ion adsorption was investigated. Cryo-TEM images revealed that sacran could be cross-linked by trivalent metal ions, and formed a fibrous nano structural network containing water. The network structure of the nanoconstructs was formed to construct macroscopic gels. The critical gelation concentrations of sacran were very low. These findings strongly suggest that the extracellular matrix of Aphanothece sacrum was gelated efficiently by the sacran associating to form nanonetworks of metal-complex fibers, which reinforced the jelly matrix. This may represent a strategy of Aphanothece sacrum for protecting their own cell bodies from external biological and physical stimuli.

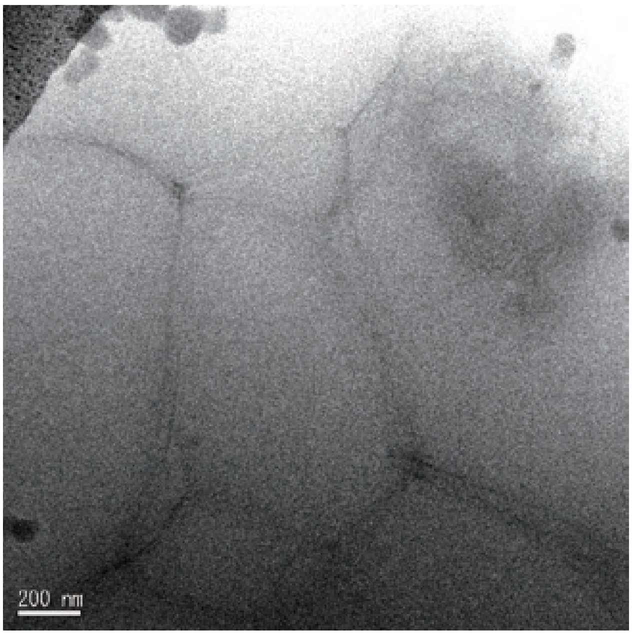

Figure 3. Cryo-TEM image of quick-frozen samples of a dispersed solution of sacran into $NdCl_3$ solution.