Research topics for graduate students for 2025

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Acceptable course(s)

- Master's Degree
- Doctoral Degree

Research Topics

We investigate the relationship between mechanical responses and microstructure changes in crystalline materials by using transmission electron microscopy (TEM) techniques, including conventional imaging, atomic-resolution imaging, spectroscopy, and in situ observations. The following research projects are proposed for graduate students:

1. Development of in situ mechanical test system for atomic-resolution transmission electron microscope

Deformation and fracture of crystalline materials originated from atomic displacements and atomic bond breaking. In situ TEM mechanical testing provides information on microstructural evolution and mechanical responses during deformation and fracture behavior. We are developing loading devices for in situ TEM mechanical testing based on MEMS technology [1].

2. Structural analysis of lattice defects in crystals

Crystals involve defect structures such as dislocations, twins, or grain boundaries, and they control materials' properties. It is important to identify their structural features to understand the effects of lattice defects. Through TEM observations and theoretical characterization, the detailed structures of lattice defects are investigated [2, 3].

3. Dynamic observations of lattice defects by in situ TEM mechanical testing

Deformation and fracture of crystalline materials originated from atomic displacements and atomic bond breaking. In situ TEM mechanical testing provides information on microstructural evolution and mechanical responses during deformation and fracture behavior. Using nanoindentation system or MEMS loading system for in situ TEM, the dynamic behavior of lattice defects upon loading is investigated from sub-micrometer to atomic scale [4].

Articles Related to Research Topics

[1] T. Sato, E. Tochigi, T. Mizoguchi, Y. Ikuhara, H. Fujita, *Microelectro. Eng.* **164**, 43-47 (2016).

[2] E. Tochigi, A. Nakamura, N. Shibata, Y. Ikuhara, *Crystals* **8**, 133-1-14 (2018).

[3] E. Tochigi, Y. Kezuka, A. Nakamura, A. Nakamura, N. Shibata, Y. Ikuhara, *Nano Lett.* **17**, 2908-2912 (2017).

[4] E. Tochigi, B. Miao, A. Nakamura, N. Shibata, Y. Ikuhara, *Acta Mater.* **216**, 117137, (2021).

Lab. Web page: https://sites.google.com/g.ecc.u-tokyo.ac.jp/nanoscale-strength