Microstructure analyses using advanced electron microscopes

Faculty of Engineering and Design, Kagawa University. Prof. Yasuhiro Tanaka
E-mail: tanaka@eng.kagawa-u.ac.jp

1. Microstructures and properties of materials

Material properties and performance of even the same substance are different depending on their microstructures. The microstructure of a perfect crystal that does not contains any defects is uniform. Existence of many kind of defects that are imperfections of atomic periodicity makes wide variety of microstructures. Optimizing the microstructure gives the best performance of materials. Because the origin of microstructure is atomic level imperfections, atomic level investigations are required.

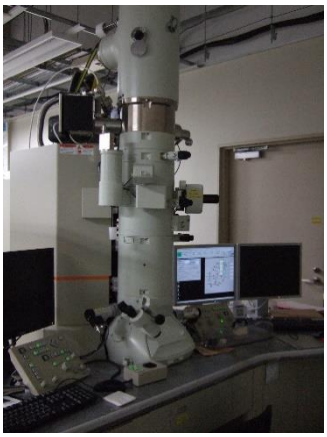
2. Microstructure observations using electron microscopes (EMs)

Three types of electron microscopes are installed in our faculty. Scanning electron microscope (SEM) with field emission gun (FEG) is equipped with analytical attachments like EDX, WDX, EBSD, CL detectors. Transmission electron microscope with FEG possesses an atomic level resolution and is installed scanning unit, so, high-resolution elemental mapping and HAADF observations are also achieved. Focused ion beam (FIB) is able to pick up thin TEM observation samples from the point we need to observe. Three types of electron microscopes FESEM, FETEM, FIB are essential tools to evaluate the effects of microstructure on materials performance.

Electron microscopes in Faculty of Engineering and Design

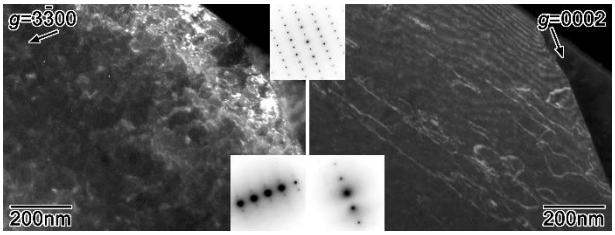
Field Emission (FE) Scanning EM
FESEM: Surface microstructure
EDX & WDX: Elemental mapping
EBSD: Crystallographic orientation
Cathodoluminescence

Focused Ion Beam (Dual Beam)
FIB + SEM: Dual Beam
FIB: Ga-ion Beam
Pt-deposition: Protect Layer
Omniprobe: Sample pickup

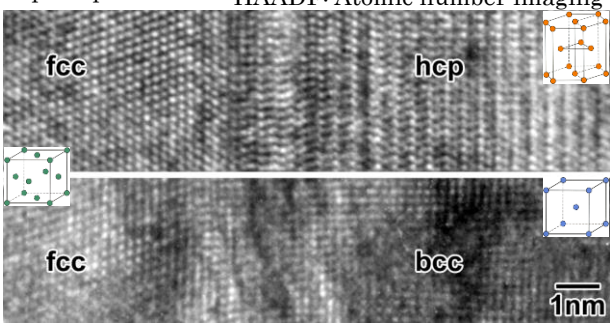


FE Transmission EM
HRTEM+CCD: High-resolution
STEM-EDX: Elemental mapping
HAADF: Atomic number imaging

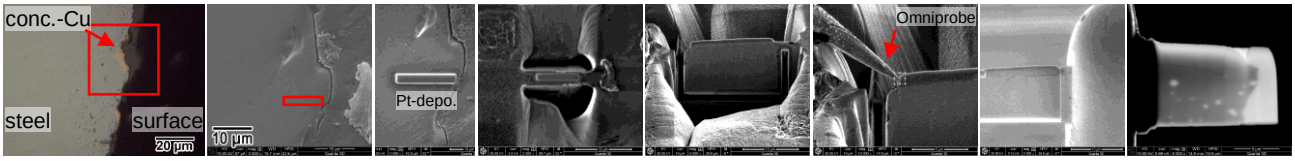
3. Microstructure analyses



Weak beam dark field images characterize the Burger's vector of dislocations. In additions, using diffraction patterns indicating crystal orientations, dislocation types are also clarified.



Austenite stainless steel chages crystal structure by strain induced martensite. Crystallographic relations between matrix and martensites are clearly realized using high-resolution TEM observations.



OM image SEM, FIB images→ Pickup sample Fix on pillar TEM sample

Sequence of TEM sample pick up using FIB