Introduction of JEM-ARM 200F, the Atomic Resolution STEM/TEM

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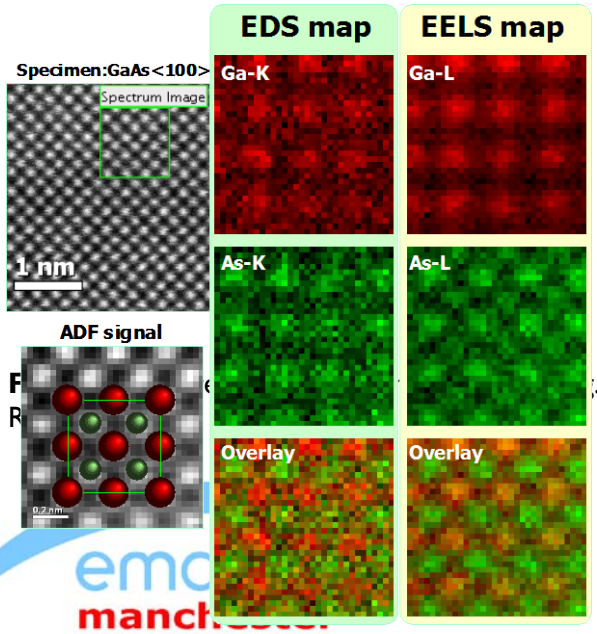
Modern Scanning Transmission Electron Microscopy (STEM) with aberration correctors allows us to achieve atomic resolution and obtain a variety of information depending on the detection angles of transmitted and scattered electrons. The High Angle Annular Dark Field (HAADF) image, which is formed from the highly scattered electrons (about 50 mrad), shows the Z-dependent contrast of individual atomic columns. The Annular Bright Field (ABF) image [1, 2], which is obtained by detecting an annular-clipped disk of directly transmitted electrons, is effective in imaging light elements simultaneously with heavy elements. Recently, visualization of the atomic position of Hydrogen in a crystalline specimen was reported by several groups [3,4].

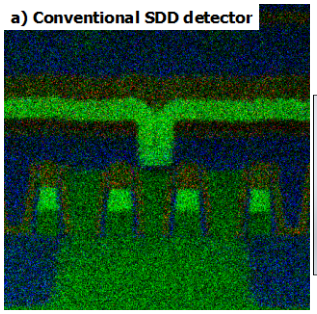
On the other hand, to determine an atomic element, an Energy Dispersive x-ray Spectrometer (EDS) and/or an Electron Energy Loss Spectrometer (EELS) are usually used with STEM to achieve atomic resolution. Fig.1 shows an example result of EDS and EELS mapping at atomic resolution. The difference of atomic number is only 2 between Ga(31) and As(33). In this case, identification of the atomic species and positions in the HAADF image becomes difficult, but this information was determined by the measurement of the elemental signal from EELS and EDS.

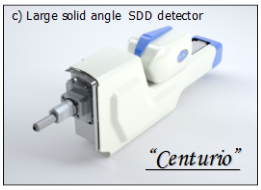
A large solid angle SDD-type EDS detector has been developed by JEOL for high performance analysis and high sensitivity by using a 100mm2 x-ray sensor. Fig. 2 shows a comparison result of fast (1 min acquisition) EDS mapping using conventional (30mm2) and large solid angle (100mm2) detectors. The oxide and nitride layers in the semiconductor device are visible clearly in fast mapping conditions.

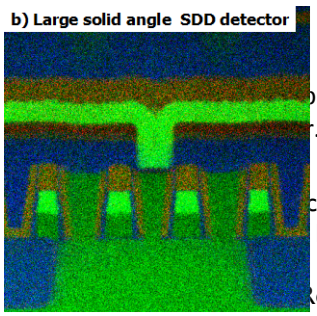
In recent years transmission electron microscopy has seen many improvements. JEOL has released an atomic-resolution analytical electron microscope (JEM-ARM200F) which has excellent capability in imaging and analysis at the atomic level with several new features. Improved Cold-FEG has better E-resolution and the smallest STEM probe, ABF can visualize lighter and heavier elements simultaneously.

We will present more information for imaging and analysis about TEM /STEM in this workshop.









Mapping condition
Mapping time : **1** min
512x512 pixels

Red:N-K map
Green:Si-K map
Blue:O-K map

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3. Ishikawa, R. et al. Nature Mater. 10, (2011) 278–281.
4. Findlay, S. D. et al. Appl. Phys. Express 3, (2010) 116603.