3D characterization of MTJ device by STEM-tomography

STEM tomography is one of effective techniques to characterize of MTJ(Magnetic Tunnel Junction) device. Using STEM-tomography, 3D morphology and 3D composition distribution of the whole MTJ device can be Visualized/quantified and discussed in more detail compare to conventional 2D observation.

3D Observation Procedure

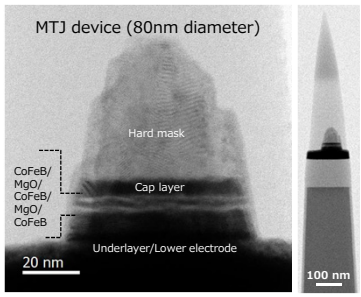
- Needle-shape sampling by FIB
- Tilt series acquisition by TEM/STEM
- Image center offset・Tilt axis calculation
- Reconstruction processing

Preparing a needle-shape sample of 100nm diameter containing the MTJ device is important for 3D observation

Microscope:
JEOL JEM-ARM200F Dual-X

Reconstruction software:
TEMography (SiF)

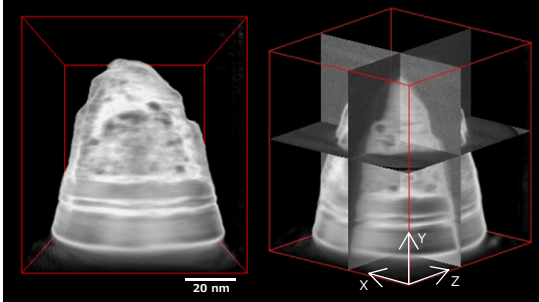
Sample offer :
Center for Innovative Integrated Electronic Systems (CIES), Tohoku University



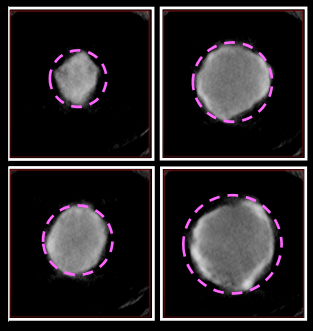
BF-STEM image(left)and a needle-shape sample(right) of MTJ device

3D Reconstruction Results

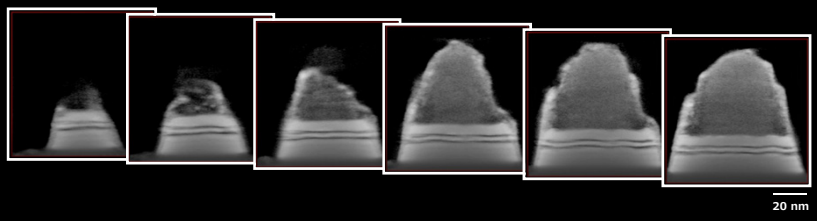
Volume-rendering Images



X-Z Slice Images

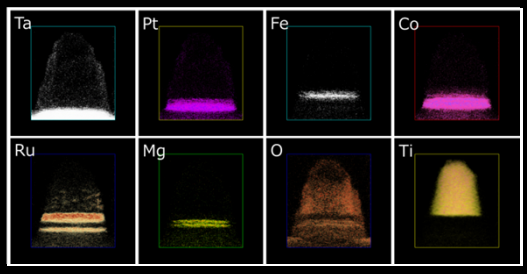


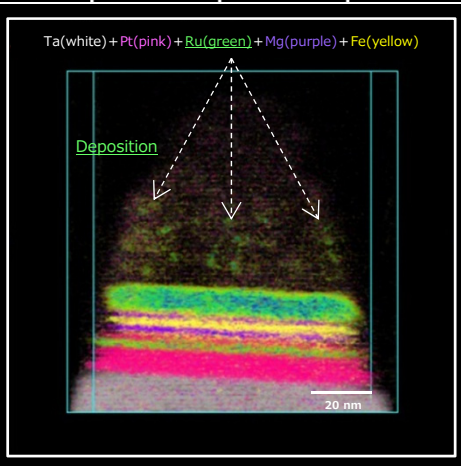
Y-Z Slice images



HAADF-STEM Tomography Results
3D morphology(upper left) and arbitrary section(X-Z slice(upper right), Y-Z slice(lower)) can be confirmed

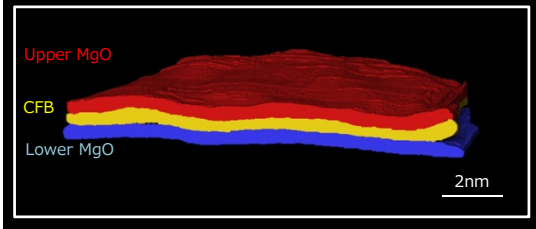
Volume-rendering Images of Each Composition

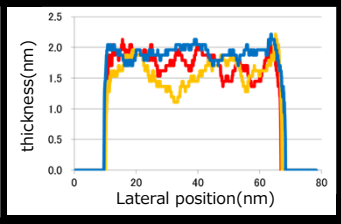




STEM-EDX Tomography Results
3D composition distribution of each element can be confirmed

Segmentation Results





Binarization image of CoFeB/MgO/CoFeB(left) and thickness distribution(right)
Thickness and roughness can be discussed quantitatively

Using STEM-tomography, 3D morphology of MTJ device can be visualized, and the deposition of sidewall can be evaluated in 3D. In addition, quantitative information can be obtain from arbitrary section and segmentation results. It is highly expected that STEM-tomography gives feedback on MTJ etching process.