In-situ observation in aberration corrected TEM

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Abstract

*A various experimental results in In-Situ obser*vations which were combined with aberration corrected transmission electron microscopy (Cs-corrected TEM) are introduced. In this lecture, the features and the performances of newly developed Cs-corrected TEM and a various kind of *In-Situ* specimen holders are introduced in detail.

Introduction

Owing to the aberration corrected TEM/STEM, atomic resolution observation and analysis are commonly used, today [1]; however, the TEM specimen is kept under high-vacuum condition. It is very important to investigate the structures analysis of materials under practical operating environment; therefore the *In-Situ* observation technology is becoming very important. Recently, a various kinds of *In-Situ* specimen holders have been developed; the *In-Situ* observation can be introduced into the market. And also, JEOL developed Cs-corrected TEM with wide gap objective polepiece for accepting the *In-Situ* holders and offering higher efficiency X-ray signal collection.

Results and discussions

Figure 1 shows an appearance of newly developed Cs-corrected TEM (*JEM- ARM300FII*). The cold field emission gun (cold-FEG) is employed and owing to a small energy spread and a high-coherency of electrons of cold-FEG, a TEM lattice resolution of 60 pm (Cs-corrected with WGP at 300 kV) is performed. And dual type of largest size of EDS detector (158 mm^2, each) can be installed into the wide-gap objective polepiece (WGP); thus, the X-ray collection solid angle becomes very large as 2.21 sr. for analytical capability.

Figure 2 shows an example of *In-Situ* observation of Ir/CeO_2 catalyst redox reaction obtained at specimen temperature of 600 deg. C. with gas environment holder (*Protochips Atmosphere*) and *ARM300FII*, and gases were transferred as $H_2 - O_2 - H_2$. The Ir/CeO_2 catalyst redox reaction was observed at atomic resolution.
Figure 3 shows another example of *In-Situ* observation of electrochemical reaction (copper electro plating) obtained with liquid environment holder (*Protochips Poseidon*) and *ARM300FII*. The copper plating layer growing in a cupric sulfate solution is observed dynamically.
Owing to *In-Situ* specimen holders and aberration corrected TEM combination, the *In-Situ* observation is realized.

References

[1] C. Ricolleau et al.; *Microscopy 62 (2013) 283 – 293.*

Fig. 1. Appearance of newly developed Cs-corrected TEM (*JEM-ARM300FII*).

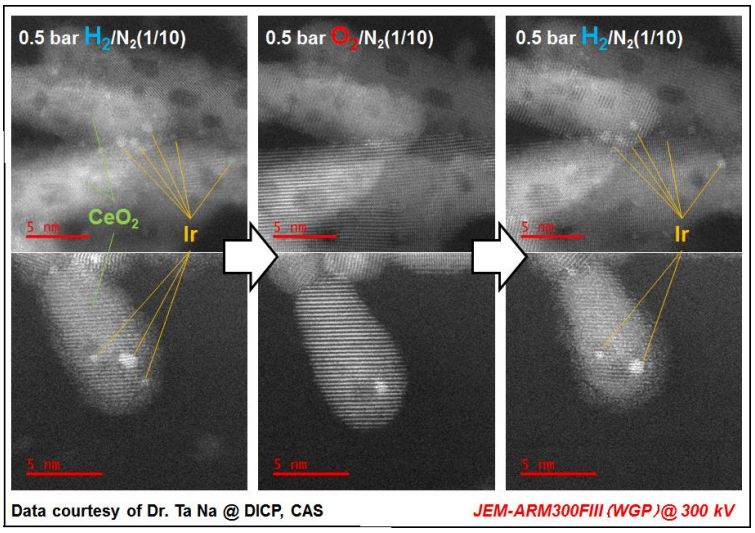

Fig. 2. *Ir/CeO₂* catalyst redox reaction @600 deg C. The gases were transferred as $H_2 - O_2 - H_2$ in gas environment holder.

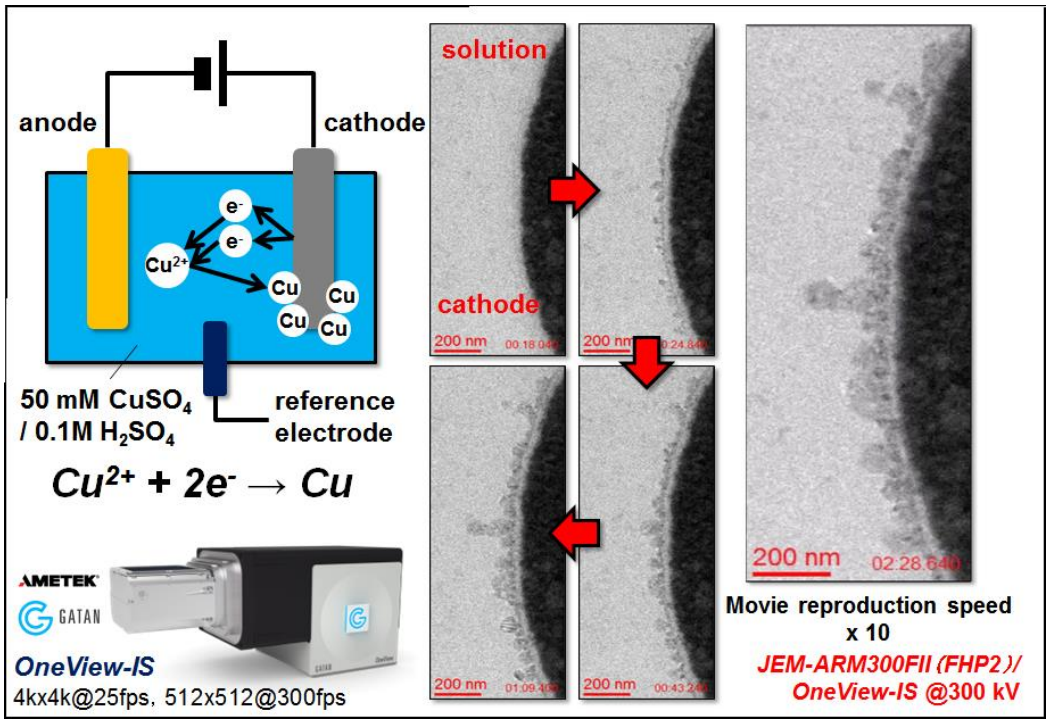

Fig. 3. Electrochemical reaction (copper electro plating)
The copper plating layer growing in a cupric sulfate solution is observed dynamically with liquid environment holder (*Protochips Poseidon*) and *JEM-ARM300FII*.

Detector: *Gatan OneView Insitu.*