Development of environmental high-voltage electron microscope for reaction science

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Environmental transmission electron microscopy is recently of a great interest as well as ultra-high resolution observation using aberration correctors. This method is a kind of extension of so-called "in-situ electron microscopy" performed since the 1970's. It nowadays focuses on dynamic observation with atomic resolution in gaseous atmosphere and liquids. Since 2007, Nagoya University has developed a new 1 MV high voltage (scanning) transmission electron microscope, where nano-materials can be observed in conditions of gases.

Figure 1 shows high-resolution lattice images of a [001] oriented gold (Au) film in vacuum condition and gaseous ones. At 11,000 Pa of nitrogen gas, we can clearly observed (200) lattice fringes of gold. This is the world top datum for HRTEM image in gaseous conditions by using the open-type environmental cell.

Figure 2 shows the sample was prepared by vacuum-deposition of copper particles onto commercial silica (SiO_2) powders inside the HVEM. A low magnification bright field image of the sample with copper deposited (Fig.2 a)). The in-situ oxidation was made at 700℃ by introducing oxygen gas of 1 Pa (Fig.2 b), c), d)). The oxidative process of copper particles was observed dynamically changing on TV image. It became clear that Cu changed to CuO from the copper *L*-edge peak in EELS spectra.

Reference

[1] N. Tanaka et al., Microscopy , Vol. 62, 1 (2013) 205-215

[2] N Tanaka et al., Proc. Int. Microscopy Congress-17 (2010) I9-2.

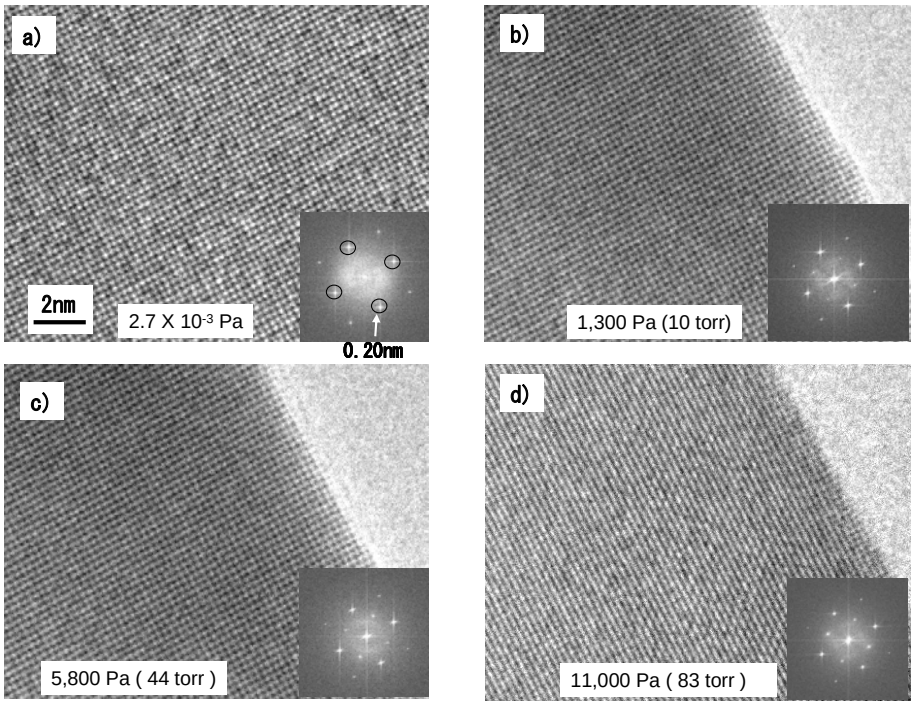

Fig.1. (200) lattice fringes of a (001) gold film. a): under vacuum, b) :1,300Pa, c) :5,800Pa and d): under 11,000 Pa of nitrogen gas at 1 MV.

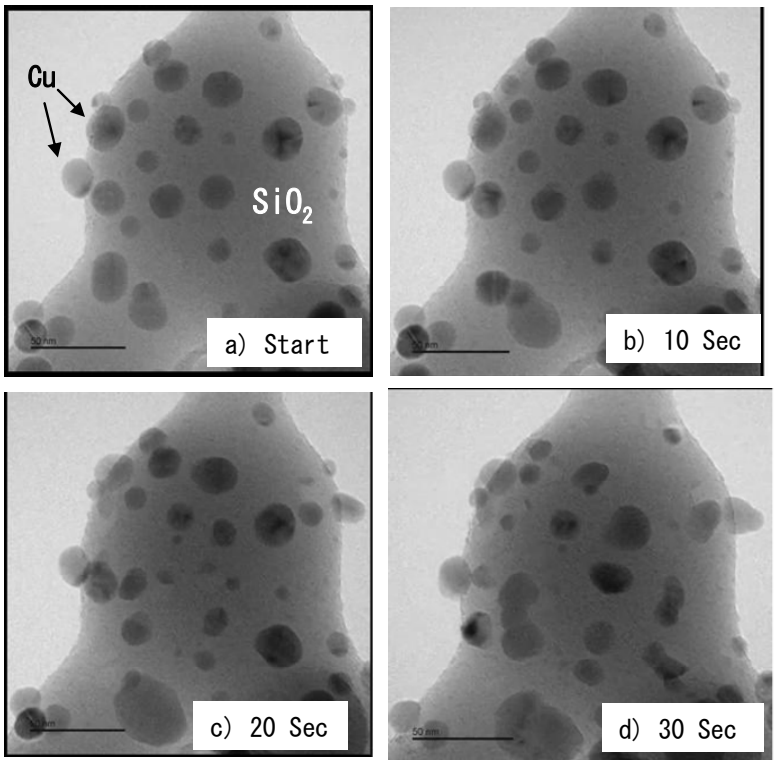

Fig.2. In-situ oxidation of Copper particles (at 700℃) by introducing oxygen gas of 1 Pa. a): under vacuum, b): introduce O_2 gas after 10sec, c): after 20sec, d) after 30sec