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DEVELOPMENT OF NEW ENVIRONMENTAL HIGH-VOLTAGE TRANSMISSION ELECTRON MICROSCOPE EQUIPPED WITH QUADRUPOLE MASS SPECTROMETER FOR OBSERVING CATALYTIC REACTIONS

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In this paper, we introduce the new high-voltage electron microscopy-quadrupole mass spectrometer (HVEM-QMS) system and demonstrate redox reactions where the product gas species are unambiguously detected, associated with the expected structural changes, as follows: (i) CO_2 as a result of carbon nanotube (CNT) combustion by a Pd nano-particle catalyst in O_2 atmosphere was detected when a mixture of a CNT bundle and Pd fine particles was heated in ~10 Pa of O_2 gas. The Pd particles started to move around in CNTs > ~200°C, and it appeared that the Pd particles decomposed the CNTs, because carbon atoms contacting Pd particles surface were burned to CO_2, when QMS of m/Z 44 was detected; a good correlation was obtained between the TEM image and Q-Mass spectra, without a significant delay of the CO_2 detection onset with respect to the start of the Pd particles motion. (ii) Reduction of Rd_2O_3 nano-particles in vacuum: Rd_2O_3 nano-particles supported on ZrO_2 substrate were heated in vacuum, which was reduced to metal at temperatures > ~200°C. Interestingly QMS detected no oxygen even during the transformation of Rd_2O_3 to metallic Rh. Instead species of m/Z 44 (in the form of CO_2) were unambiguously detected. This suggests that the emitted oxygen atoms were so chemically active in the atomic form as to instantly react with the surrounding carbon-origin contaminations, forming CO_2. Further demonstrations will be presented.

BIOGRAPHY

Muto S has completed his PhD at the age of 28 years from Osaka University, Japan. He is the professor of Institute of Materials and Systems for Sustainability, Nagoya University, Japan and the director of High-Voltage Electron Microscopy Laboratory of Nagoya University. He has over 200 publications that have been cited over 2500 times, and his publication H-index is 27. His main interest is to visualize physical/chemical properties of various functional materials at nanometer scale, using transmission electron microscopy/spectroscopy techniques.

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