In-situ and 3-dimensional Nano-Transmission X-ray Microscopy at NSRRC

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Transmission X-ray microscopy is an efficient instrument in in-situ and interior 3-dimensional structural observation of material in nano- to sub-micron scale owing to its large penetration depth and superior spatial resolution. The nano-transmission X-ray microscopy (TXM) at beamline BL01B [1,2] of the Taiwan Light Source (TLS) provides two-dimensional imaging and three-dimensional tomography at energy 8-11 keV with a spatial resolution of 50-60 nm, and with the Zernike-phase contrast capability for imaging light materials such as biological specimen. TXM allows aqueous specimen due to no vacuum requirement. This beamline now carries out successfully the researches that prefer a non-destructive probe, for example, (1) in-situ observation of the sulfidation process of nano cubes, supercrystal formation process and energy storage Li-ion battery (2) the characterization of porous material such as earthquake fault gauge, paleontological fossil and clay mineral in aqueous environment (3) the analysis of the failure mechanism in micro-electronic device. Furthermore, this X-ray microscopy can be applied in the research of cells in life science. With labeling contrast agents, such as immuno nano-gold or osmium tetroxide, imaging for specific cellular function is feasible.

In this presentation, I will demonstrate the applications utilizing transmission X-ray microscopy at NSRRC: (1) In-situ observation of the sulfidation process of Cu_2O nano-particle [3]. (2) Formation of polyhedral gold supercrystals [4]. (3) Study on the interior microstructures of working metal or SnSb particle electrode of Li-ion batteries [5]. (4) 3-dimensional interior structure of geological specimen [6].

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[1] Gung-Chian Yin, Mau-Tsu Tang, Yen-Fang Song, Fu-Rong Chen, Keng S. Liang, Frederick W. Duewer, Wenbing Yun, Cheng-Hao Ko, and Han-Ping D. Shieh, Appl. Phys. Lett., **88**, 241115 (2006)

[2] Y. F. Song, C. H. Chang , C. Y. Liu, S. H. Chang, U-Ser Jeng, Y. H. Lai, D. G. Liu, J. F. Lee, H. S. Sheu, M. T. Tang, K. L. Tsang, and K. S. Liang, J. of Synchrotron Rad. **14,** 320 (2007)

[3] Chun-Hong Kuo, Yi-Ting Chu, Yen-Fang Song, and Michael H. Huang, Adv. Funct. Mater. **21**, 792 (2011)

[4] Ching-Wen Liao, Yeh-Sheng Lin, Kaushik Chanda, Yen-Fang Song, and Michael H. Huang, J. Am. Chem. Soc. **135**, 2684-2693(2013)

[5] Sung-Chieh Chao, Yen-Fang Song, Chun-Chieh Wang, Hwo-Shuenn Sheu, Hung-Chun Wu and Nae-Lih Wu, J. Phys. Chem. C **115**, 22040-22047 (2011).

[6] Yu-Min Chou, Sheng-Rong Song, Charles Aubourg, Teh-Quei Lee, Anne-Marie Boullier , Yen-Fang Song, En-Chao Yeh, Li-Wei Kuo, & Chien-Ying Wang, Geology **40** 551-554 (2012).