In-situ straining and time-resolved electron tomography data acquisition in TEM

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Here we report an in-situ three-dimensional (3D) imaging system for observing plastic deformation behavior in transmission electron microscopy (TEM) [1] as a directly relevant development of the recently reported straining-and-tomography holder [2]. We designed an integrated system using the holder and developed the straining and image-acquisition software and then developed an experimental procedure for in-situ straining and time-resolved electron tomography (ET) data acquisition. The software for image acquisition and 3D visualization was developed based on the commercially available ET software 'TEMography'. We achieved time-resolved 3D visualization of nanometer-scale plastic deformation behavior in a TEM sample, such as Pb-Sn alloy (Fig. 1), thus demonstrating the capability of this system for potential applications in materials science.

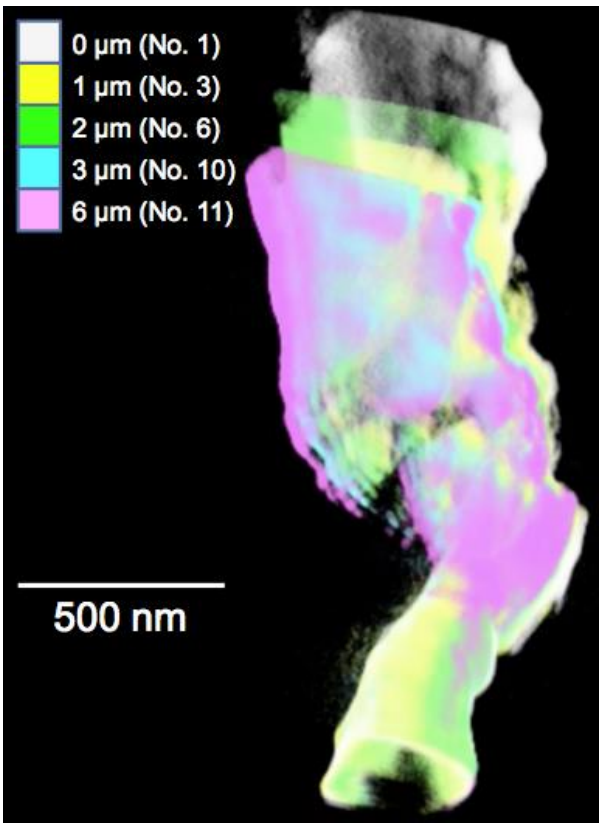

Fig. 1. Superposition of 3D reconstructed volumes of a deformed Pb-Sn alloy sample [2]. The 3D frame No. 1: the starting position for the straining and tilt-series data sets acquisition experiment; No. 3: 1 µm displacement of the actuator from No. 1; No. 6: 2 µm displacement; No. 10: 3 µm displacement; No. 11: 6 µm displacement. The average acquisition time for each tilt-series data set (41 TEM bright-field images) was less than 2 min and the total time for sample straining, microscopy alignments and the eleven 3D frames acquisition was 85 min.

[1] Hata S. et al., Microscopy, 66, 143-153 (2017).

[2] Sato K. et al., Microscopy, 64, 369-375 (2015).

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