MAR09-2008-020161

Abstract for an Invited Paper
for the MAR09 Meeting of
the American Physical Society

Quantitative electron tomography and its application to polymer nanostructures

HIROSHI JINNAI, Department of Macromolecular Science and Engineering, Kyoto Institute of Technology

The transmission electron microtomography (TEMT) is a powerful tool to visualize three-dimensional (3D) structures in many fields of materials science. Recently, researchers are trying not only to visualize 3D nano-structures but also to quantify them in order to seek a possible correlation between the 3D structures and materials' properties. However, one of the serious problems that prohibit TEMT from truly quantitative 3D images is the "missing wedge" in the Fourier space that is caused by the limitation of angular range available in transmission electron microscopes (TEM). Please note that the computerized tomography (CT), on which TEMT is based, requires projections from entire tilt angles, i.e. $\pm 90^\circ$. Thus, the most faithful tactics for the CT is to tilt specimen over $\pm 90^\circ$. In order to realize such requirement, a rod-shaped ZrO_2/polymer nano-composite whose diameter is ca. 150 nm was attached at the tip of a specially modified specimen holder without any supporting film. A complete set of tomograms has been generated for the first time from the 181 projections that were taken over the angular range of $\pm 90^\circ$. One of the structural parameters characterizing the nano-composite, a volume fraction of ZrO_2, φ, was measured as a function of the maximum tilt angle, α. It was found that φ was in excellent agreement with the known volume fraction of ZrO2 when α=90°, i.e., $\pm 90^\circ$ tilt, while φ increased with decreasing α. When α=60° that is a typical maximum tilt angle, the measured φ was larger by 20∼30% than the true value. In addition to the above TEMT experimental technique, some applications of TEMT to polymer nano-structures will be presented at the conference time.