Structure-property Relationship of Polymeric Materials Studied by Electron Tomography

Hiroshi Jinnai[a,*]

[a] *Institute of Multidisciplinary Research for Advanced Materials (IMRAM), Tohoku University, 2-1-1, Katahira, Aoba-ku, Sendai, 980-8577, Japan*

*E-mail address: hjinnai@tagen.tohoku.ac.jp

Keywords: Transmission electron microscopy / Transmission electron microtomography / Rubber nano-composite / Finite element analysis

A variety of polymeric materials from daily commodities to high-tech-products are used in our daily life. Rubber nano-composites are one of the representative polymeric products. They are often composed of one or two nano-fillers, i.e., carbon black (CB) and silica (Si) nano-particles. The three-dimensional (3D) morphology of particulate fillers embedded in a rubbery matrix (hereafter called a rubber nano-composite) was examined by transmission electron microtomography (TEMT).

Although the CB and Si nano-particles were difficult to distinguish by conventional transmission electron microscopy (TEM), they appeared different in TEMT: the CB and Si nano-particles appeared, respectively, to be hollow and solid particles in the cross-sectional images of the TEMT 3D reconstruction. Thus, TEMT itself provided a unique particle-discriminative function [1]. The nano-particles were found to form aggregates in the matrix. It is intriguing that each aggregate was made of only one species; not a single aggregate contained both the CB and Si nano-particles [1]. The 3D images of the rubber nano-composite can be further used together with a computer simulation method, the finite element analysis, to estimate the mechanical property of the material [2, 3].