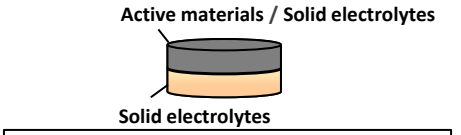
Three-dimensional analysis of the positive electrode mixture layer using the 3D-SEM method in a sulfide-based all-solid-state battery model samples

All-solid-state batteries have high safety and are expected as next-generation lithium-ion batteries. Using the 3D-SEM method, the shape and size of each part of electrode can be observed three-dimensionally. Here, we show an example of a comparative study using three kinds of model samples in which the ratio of each part of electrode (with only the active materials and solid electrolytes) was changed.

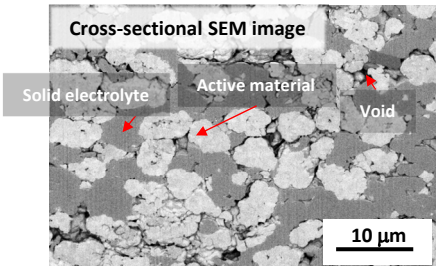
Ⅰ : 3D-SEM observation at positive electrode of sulfide-based all-solid-state battery

Schematic diagram of samples



Active materials : $LiNi_{1/3}Mn_{1/3}Co_{1/3}O_2$
NMC48 wt%, 55 wt%, 62 wt%
Solid electrolytes : Li_3PS_4

※Sample courtesy of Prof. Hayashi(Osaka Pref. University)



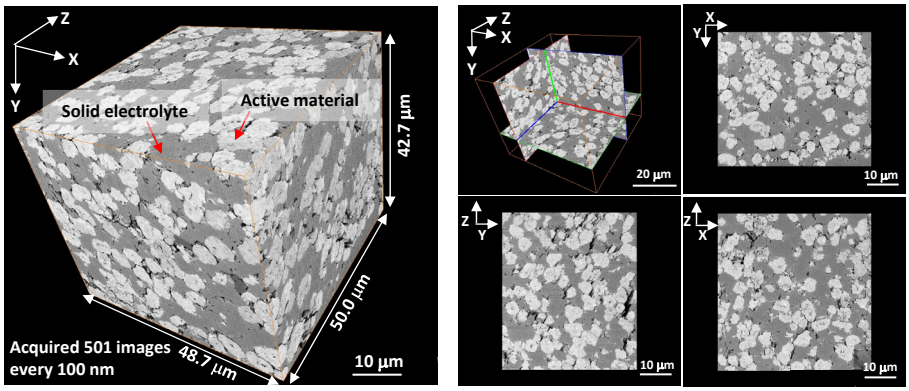
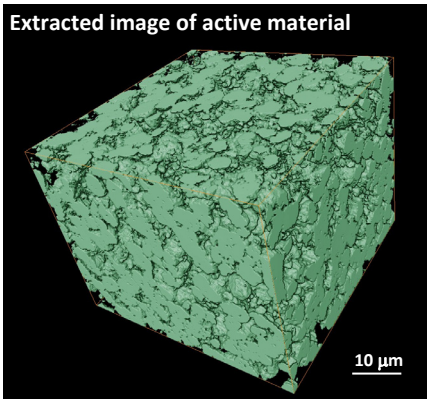


Figure 1 3D reconstruction image of NMC48 wt% (About 50 μm³)

- FIB processing and observation can be performed in an inert atmosphere.
- Three-dimensional morphological observation is possible by continuously acquiring cross-sectional SEM images.

Ⅱ : Extraction of each part and calculation of characteristic quantities by image analysis



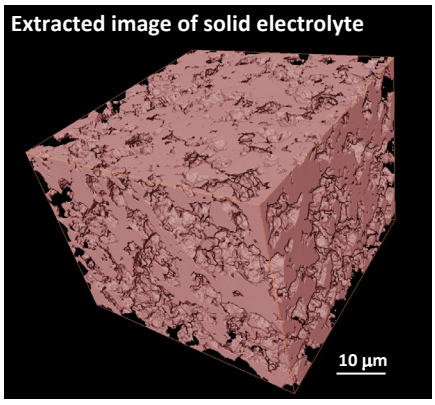


Figure 2 Extracted images of each part of NMC48 wt%

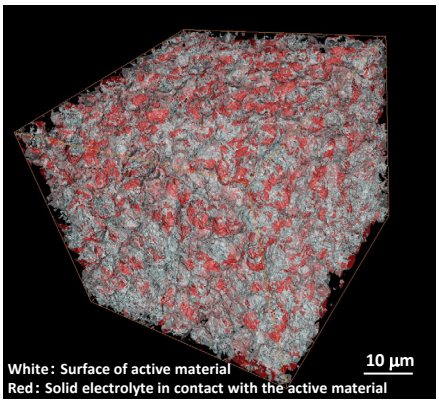
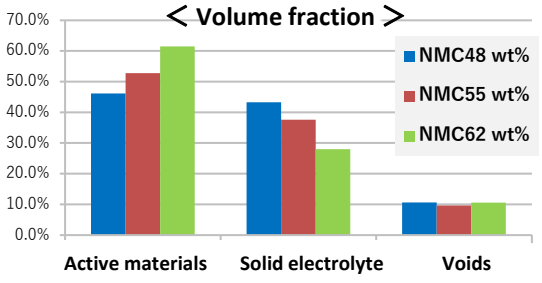
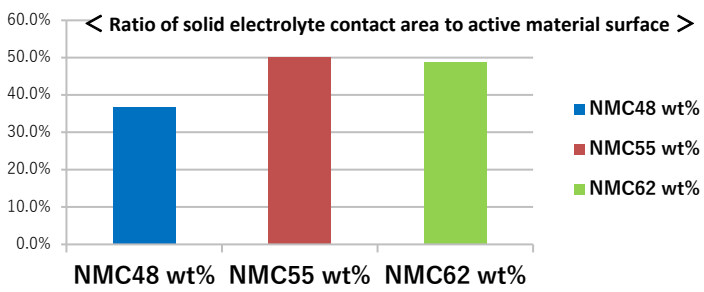


Figure 3 Extracted image of the solid electrolyte part in contact with the active material





■ Each part of an electrode can be extracted by image analysis. In addition, quantitative evaluation such as volume fraction and coverage can be performed using the extracted images.

Toray Research Center, Inc.