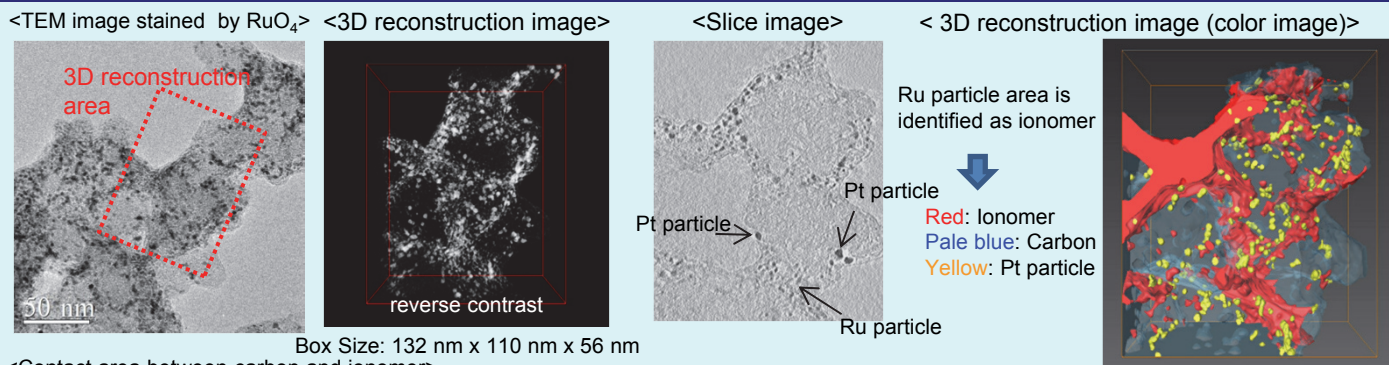


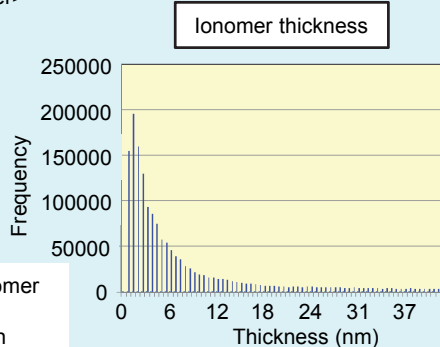
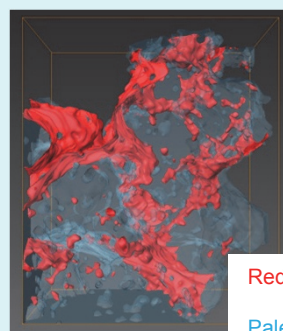
Application of the latest electron microscope technique for PEFC

By TEM tomography and image analysis technique, it is possible to obtain coverage rate and other quantitative data of ionomer in PEFC. Regarding core-shell catalyst, element distribution can be analyzed by combining aberration corrected STEM and high sensitive EDX.

Application of TEM 3D observation of ionomer and quantitative data analysis of ionomer by TEM tomography



<Contact area between carbon and ionomer>

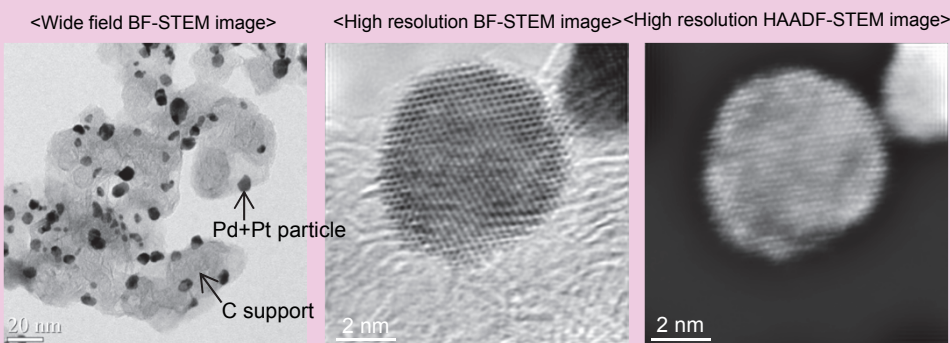


Ionomer coverage rate

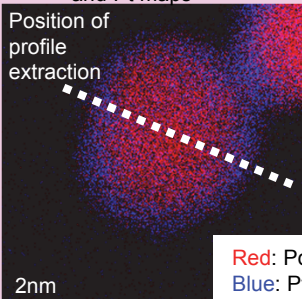
Carbon surface area = 95,336 (nm²)
Ionomer contact area = 36,604 (nm²)
Ionomer coverage = Approx. 38 (%)
Mean ionomer membrane thickness = Approx. 10.2 (nm)
Standard deviation = Approx. 14.6

In image analysis, coverage rate and membrane thickness can be evaluated by distinguishing the ionomer, carbon, and Pt particles and analyzing the contact area of each component.

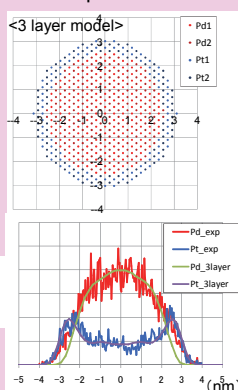
Aberration corrected STEM-EDX analysis of core-shell catalyst



<Color overlay image of Pd and Pt maps>

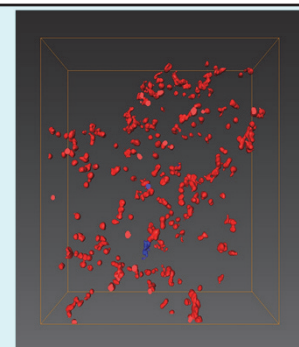


<EDX line profiles and fitting>



The combination of aberration correction, high sensitive EDX analysis, and low accelerating voltage measurement (80 kV) allow to the obtainment of a clear elemental maps of small nanoparticles about 5 nm in size, which were difficult to detect before. The Pt shell thickness distribution of a Pd-Pt core-shell structure can also be analyzed quantitatively. The number of layers can be estimated by fitting core-shell models and experimental EDX profiles.

Evaluation of Pt particles on the surface and inside the carbon



Total number of Pt particles = 189
Number of Pt particles on the carbon surface = 186
Percentage over the total particles = Approx. 98 (%)
Number of Pt particles in carbon = 3
Percentage over the total particles = Approx. 2 (%)

Pt particles on the carbon surface and those inside the carbon can be distinguished and the numbers of respective particles can be counted.

EDX detector: Silicon drift detector