Investigation of PEM fuel cell electrodes by transmission electron microscopy, scanning electron microscopy and x-ray diffraction

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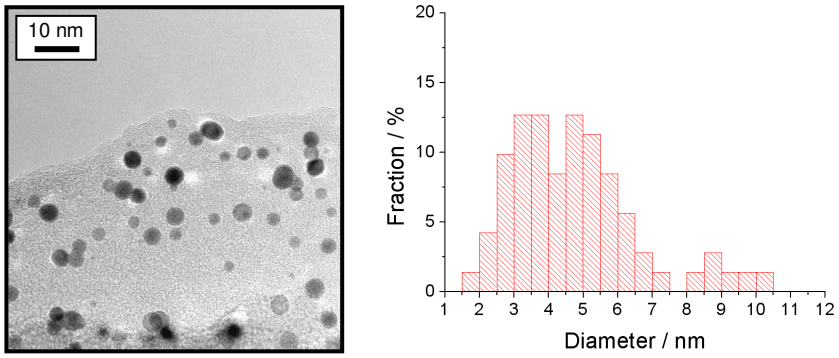
PEM fuel cells can already fulfil the performance requirements for use in mobile applications (e.g. cars), while cost and durability are still very relevant issues. In this context, growth of catalyst nanoparticles is one of the most important degradation mechanisms.

PEM fuel cell electrodes were investigated by transmission electron microscopy (TEM), scanning electron microscopy (SEM) and x-ray diffraction (XRD). This combination of methods is beneficial as TEM and XRD are complementary methods for the evaluation of catalyst nanoparticles size. TEM allows direct imaging while XRD allows averaging of relatively large sample volumes. In addition, SEM allows the investigation of larger surfaces of the electrode while catalyst nanoparticles are still detectable.



TEM photo of carbon-supported Pt-on-Au catalyst nanoparticles and corresponding size distribution

As one example of the application of these techniques, catalyst nanoparticles were characterized before and after thermal treatment, in the frame of temperature-dependent CO desorption kinetics experiments, which are of importance for a better understanding of the fundamental physicochemical processes involved in improving CO tolerance. Particle diameter distributions of Pt and Pt-on-Au based catalyst material were determined from TEM data and compared with average sizes calculated from XRD data. For the Pt-on-Au based catalyst, TEM and XRD results might suggest that the real catalyst structure deviates from core/shell particles which might be expected when only considering the preparation method.