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Towards a Quantitative Understanding in Electron Tomography

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State-of-the-art electron tomography is now a versatile tool for visualizing morphologies and particle distributions in 3D for a wide range of applications. Some prominent examples come from such diverse areas as catalysis [1], semiconductor materials [1,2], block copolymers [3], polymer composites [4] and biological applications [5].
In addition to improving the resolution in 3D, one of the major aims in (electron) tomography is to move from purely qualitative imaging towards fully quantifiable results. In most cases, an ideal reconstruction of the 3D volume with noise limiting the image segmentation process is assumed for the quantification. Therefore, the implicit assumption is that in the absence of noise and with a complete tilt-series, identical materials within a sample should result in identical intensities in the reconstructed volume. However, our recent experimental results on different high-contrast data sets clearly show that this assumption is not valid. The reconstructed intensities are strongly dependent on the feature size and vary by 1-2 orders of magnitude for the same material within one reconstruction. This effect is present with SIRT and with WBPJ, however the exact dependency varies for both of them. These experimental findings have been confirmed using simulations assuming perfect projection conditions. These results and their strong implications for particle detection and quantification of any tomographic data will be discussed.

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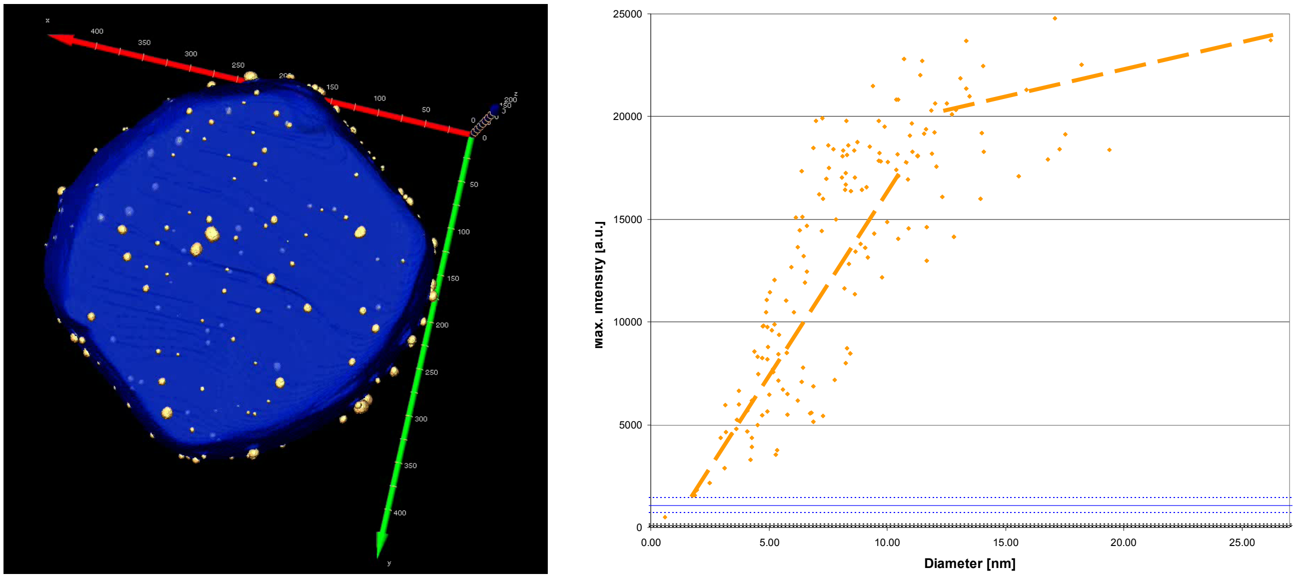

FIG. 1. Surface rendering of metal catalyst nanoparticles supported on a mesoporous silicate. The quantitative analysis of the reconstructed image intensities reveals a strong feature size dependence.

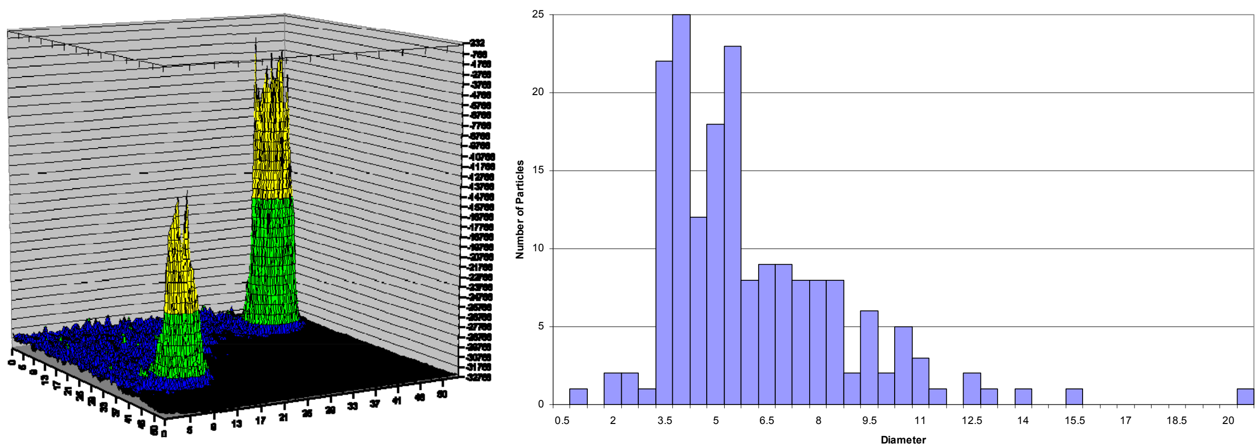

FIG. 2. The image segmentation was performed by local FWHM segmentation of every single particle resulting in a reliable particle size distribution.

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