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Abstract

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Information depth in backscattered scanning electron microscopy

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In many fields of science and technology, the quantification of nanoparticles dispersed in a solid matrix is an important task. This is often accomplished by transmission electron microscopy (TEM) which is expensive and laborious. Scanning electron microscopy (SEM) is far more affordable, offers easier sample preparation, and a larger analytical area. However, the information depth in backscattered SEM is usually unknown as it depends on acceleration voltage, chemical composition of matrix and particles, as well as the size of the embedded particles. When the information depth is unknown, volumic number densities and unskewed size distributions cannot be obtained.

Here we present a stereological technique for the quantification of nanoparticles by backscattered SEM that takes size and composition of sub-surface particles into account and assigns information depth accordingly. The resultant function of information depth over particle size allows for the reconstruction of the size distribution and number density. The method is based on Monte Carlo simulations of the interaction of electrons with solids containing particles and analysis of the signal-to-noise ratio. Application of the method to experimental backscattered electron micrographs and validation by TEM showed very good agreement for dispersoids in an Al alloy while using previous estimates of information depth resulted in large deviations.

The method is computationally very efficient, uses only cost-free software, and can be easily adapted to other material combinations in many fields of research. It is entirely physically based and does not require any fitting parameters.