On the application of Fresnel diffraction for measurement of a nanoparticles size

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Nowadays measurements of a small particle size are a very important problem for the nanotechnology. Among others, an electron microscopy is powerful tool for this task due to high spatial resolution. Electron microscopic images give information which difficult for unambiguous interpretation. A localization of particle's edge is a main problem limiting a possibility and an accuracy of the size measurement. Especially, this problem is most pronounced in the case of thin particles made from light elements and deposited on a supporting film of similar atomic composition. In that situation absorption contrast vanishes and the particles become visible only in defocused images. An interesting phenomenon has place when value of defocus is continuously increasing. For defocuses images Fresnel fringes appear around the edge of particle. The spreading of the fringes grows with the defocus in direction perpendicular to the particle edge. If the particle diameter is in a range of nanometres it is possible to find a value of defocus when fringes originating from opposite edges are overlapped and therefore a strong white or dark contrast appears on the particle's middle. The defocus value corresponded to the contrast extreme is a function of distance between edges and therefore allows to determine the particle diameter. Examples of nanoparticles size determination with the use of Fresnel fringes analysis and a computer simulation of experimental images of Fresnel diffraction patterns will be presented in this paper. Obtained results of the Fresnel diffraction analysis for several samples with Pd nanocrystals of different diameter will be discussed.

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