PHYSICS&ASTRONOMY
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Dissertation Defense

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Abstract

Mapping of physical properties and structure of nanomaterials by dose-controlled electron holography and precession electron diffraction

Novel nanostructures and their striking physicochemical properties, have the potential to revolutionize all science and engineering fields. Their incorporation into materials and devices, require reliable characterization methods to test and drive results. For that reason, imaging and diffraction phenomena using different irradiation sources (photons, neutrons and electrons) results essential. Transmission electron microscopy (TEM) and related analytical techniques have played a canonical role to study the structure of materials. The image forming process of the transmitted beam implies in general the interpretation of the amplitude and phase of the electron wave. Unfortunately, as detectors only register intensity, there are some physical properties (hidden within the projected crystal potential) lost during TEM data acquisition. In this way, the doctoral work incorporated both aspects, the analysis of the amplitude and phase retrieval, using precession electron diffraction (PED) and off-axis electron holography (EH), respectively. A combination of PED and phase reconstruction of electron holograms was performed to correlate the crystalline structure and magnetic properties in metallic ferromagnetic nanowires. The novelty of this work relies in the local magnetometry at individual nanowires and 2D arrays prepared with a focused ion beam. Quantitative measurements via phase retrieval was performed by separating the electric and magnetic contributions. Crystal orientation maps of polycrystalline nanowires, with a lateral resolution of few nanometers, were obtained by using an assisted-scanning indexation process capable to register thousands of patterns to finally yield the crystallographic atlas of the sample. These crystallographic maps are correlated with maps of the magnetic field produced by EH.

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