

Off-axis electron holography investigation of nano-objects' magnetic state

Morawiec, K.¹, Dluzewski, P.¹, Kret, S.¹, Baranska, M.¹, Sadowski, J.¹ and Derewnicka, D.²

¹ Institute of Physics Polish Academy of Sciences, Poland, ² Institute of Precision Mechanics, Poland

The common problem with off-axis holography method is to separate electric and magnetic internal fields, which both introduce phase shifts to the electron wave. It can be accomplished by acquiring two electron holograms at the same electric, but different magnetic conditions. Among others, two methods were developed. In the first one magnetization of objects in the absence of B_0 was determined. In this case one hologram for an upside and one for a downside orientation of a sample has been recorded. Second experiment was to acquire one hologram in the presence of $-B_0$ and another one in the presence of $+B_0$ and use them to determine change of magnetization caused by switching the direction of external magnetic field. In both cases the difference between phases restored from two acquired holograms provided us with information about internal magnetization of a sample.

Due to the fact that in the first experiment sample is turned upside down mechanically and in the second experiment the imaging conditions change, it is almost certain that an area shown on two holograms will have different scales and orientations. This problem requires application of image operations such as shift, rotation and rescaling in order to align both holograms. Small misalignment between holograms may produce significant artifacts during subtraction of restored phases. Thus, very precise alignment is necessary. For this purpose dedicated software was developed which semi-automatically aligns holograms and uses them to refine a magnetic signal. Internal electric field and magnetization in the absence of B_0 were determined for $\text{Nd}_7\text{Fe}_{75}\text{B}_{14}\text{Nb}_4$ alloy sample (Fig. 1).

Results of the in-situ Lorentz microscopy measurements for $\text{Nd}_7\text{Fe}_{75}\text{B}_{14}\text{Nb}_4$ and $(\text{Ga},\text{Mn})\text{As}$ nanocrystals, as well as software for off-axis holography reconstruction, will be presented and ideas for future applications will be discussed.

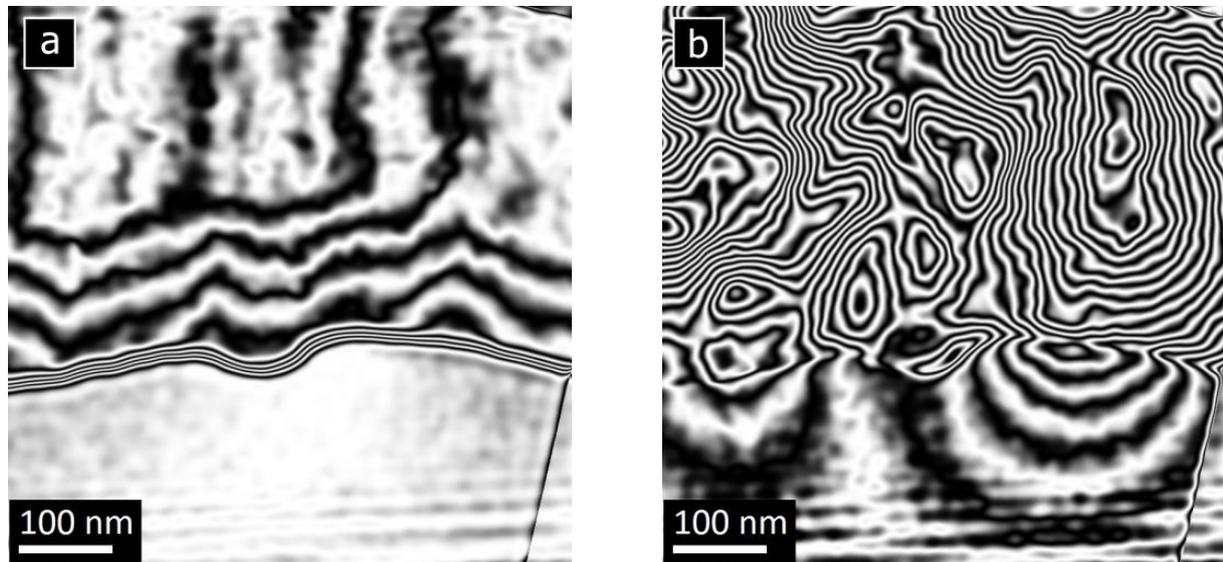


Fig. 1. Electric (a) and magnetic (b) phase images restored from a pair of upside-downside holograms of $\text{Nd}_7\text{Fe}_{75}\text{B}_{14}\text{Nb}_4$ sample in a liquid nitrogen temperature.

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