

Electron Differential Phase Microscopy with an A-B Effect Phase Plate.

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Observations of weak phase objects, such as thin films of light elements, thin polymer films, biological sections etc., are available by electron phase microscopy[1]. Many of phase plates utilized are thin film types. Some electrostatic types have been developed[2, 3], but they are not so general, because the fabrication of the filter with fine structures is very difficult. The mainstream of today's phase plate is the thin film type. This type of the phase plate, however, has some disadvantages, i.e. control of the film thickness, charging up, contamination and so on.

We adopted the phase plate with a magnetic thin filament which generates the vector potential around itself by an Aharonov-Bohm (A-B) effect. The filament type phase plate with the A-B effect was proposed and constructed firstly by Nagayama. This type of the phase plate generates the differential phase contrast in the image, and has a longer life time than the thin film type. Any clear differential effect, however, has scarcely reported so far. We will report that the effect of a phase plate consisting of a Wollaston platinum filament less than 1 μm in diameter covered with ferromagnetic material, Sm-Co of 5 nm thick, deposited by a Pulsed Laser Deposition after demagnetization at 800°C. The filament with a clean surface selected by SEM is mounted on a single hole Cu grid, and re-magnetization in the field of 2.4T.

The phase difference in the both side spaces of the filament measured by electron holography shows 1.5 rad as shown in Fig.1. Being set on the aperture holder, the phase plate is inserted in the back focal plane of the objective. Figure 2 shows images of a mouse photoreceptor cell, which is fixed with Os and without staining. The differential image in Fig.2(b) observed using the phase plate shows inner structures including mitochondria clearer than in the image taken ordinary TEM in Fig.2(a). The direction of the differentiation is shown by the arrowhead.

The effects of the source size and the thickness of the filament on the differentiation will be estimated theoretically, and experiments by a 1000kV high voltage electron microscope will be reported, too.

Reference

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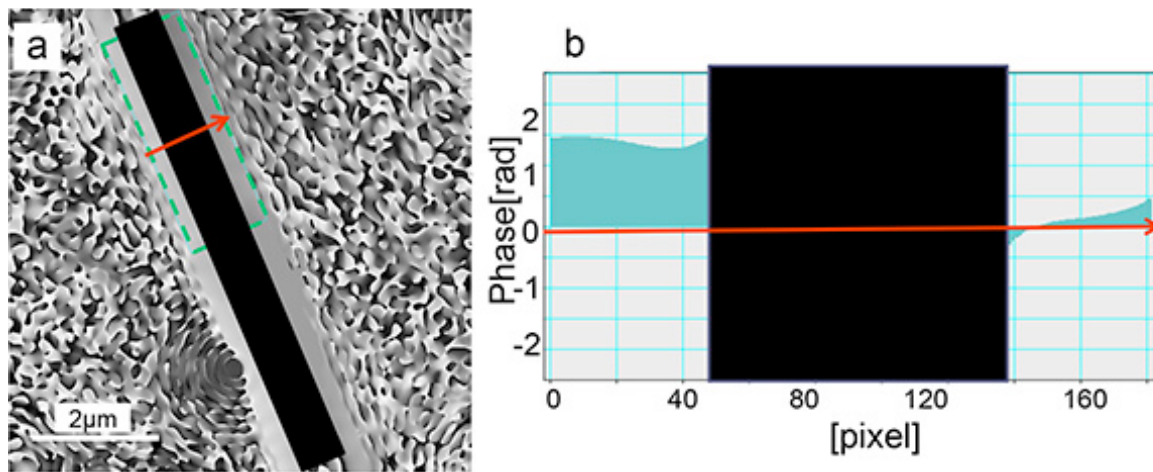


Fig.1 (a) Electron phase map reconstructed by electron holography. (b) A line profile along the arrow head in (a) which is averaged along the long side of the rectangle. The phase difference is about 1.5 rad. between both sides of the filament.

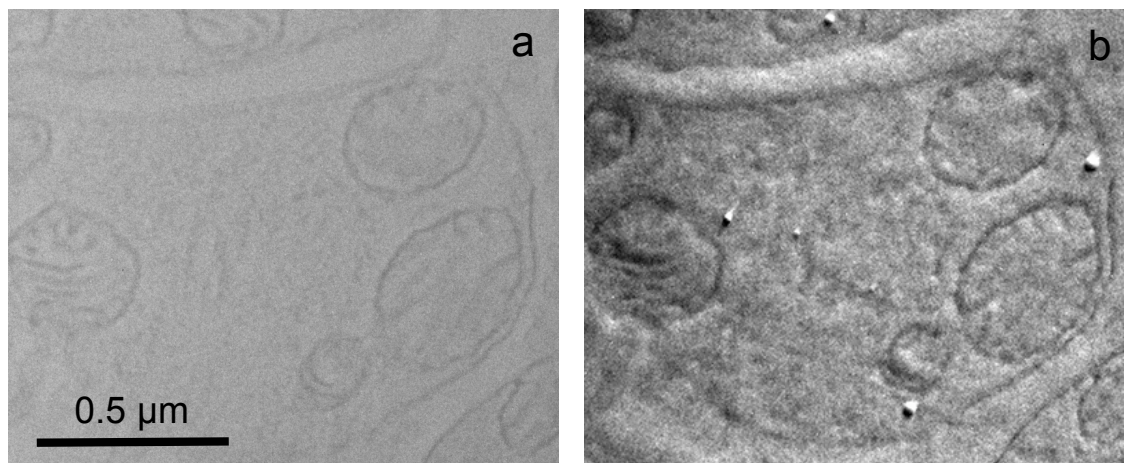


Fig.2 Images of a mouse photoreceptor cell without the phase plate (a), and with the phase plate (b).