1. Introduction

Electron holography is an imaging technique that records the electron interference pattern of an object on film (hologram) and then reconstructs an optical image by illuminating the hologram with a laser beam. In this process, electron wave fronts are transformed into optical wave fronts. Images of microscopic objects and fields that are so small that they can be observed only by using an electron beam with an extremely short wavelength are enlarged and reconstructed on an optical bench. This allows versatile optical techniques to be applied to overcome the limitations of electron microscopes.

Holography is now widely known - not only by scientists but also by artists, philosophers, and the general public - as a kind of stereoscopic photography using a laser beam. Holography was, however, originally invented in 1949 by *Dennis Gabor*, as a way of breaking through the resolution limit of electron microscopes [1.1,2]. The resolution of electron microscopy is not determined by the fundamental limitation, the electron wavelength, but by the large aberrations of the objective lens. It is impossible to construct an aberration-free lens system by combining convex and concave lenses due to the lack of any practical concave lens. *Gabor* intended to optically compensate for the aberrations in the reconstruction stage of holography. The intrinsic value of holography was not fully recognized until 1962, when *Leith* and *Upatnieks* [1.3] reconstructed clear images by using a coherent laser beam. Similarly, practical applications of electron holography have been made possible by the development of a coherent field-emission electron beam [1.4]. With this beam, electron holography has made a remarkable step towards new and practical applications [1.5-13].

To take a concrete example, the phase distribution of the electron wave function transmitted through an object has become observable to within a measurement precision as high as $2\pi/100$, while in electron microscopy only the intensity distribution can be observed. This technique has enabled us to directly observe magnetic lines of force of a magnetic object: The contour fringes in the interference micrograph follow magnetic lines in h/e ($=4\cdot10^{-15}$ Wb) units. This was applied to actual problems such as the magnetic-domain structure of a ferromagnetic thin film and also the observation of magnetic fluxons penetrating a superconductor.