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Coherent Electron Interference of Diffracted Beams from Amorphous Materials

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Interferograms produced from the electron diffraction intensities of amorphous materials have been made for the first time. Recent methods of k-space interference by means of an electron biprism have revealed that practically all electron intensities on the diffraction plane originating from a coherent electron source of a TEM have sufficient coherence to form fringes when self-interfered under a wide range of diffraction conditions [1]. The electron diffraction intensities from amorphous materials are of interest because they represent their atomic structure, which to date has not been solved because of their complexity [2] and missing phase information. Two different methods of electron interference on the diffraction plane produced interferograms with high contrast fringes. One is a wavefront-splitting method (Fig. 1) with limitations similar to off-axis electron holography produced on the image plane [3]. The other is an amplitude spitting method (Fig. 2) that interfered Bragg diffracted beams from a crystal, which carried the intensities of an amorphous thin film existing on the surfaces of the crystal [4]. Interferograms were produced from the diffuse, speckle and ring intensities of many amorphous materials including a-C, a-Si, a-Ge, SiO_2 , a-W, a-GaAs and an a-metal. The fringes in the interferograms were produced from low to high electron scattering angles, i.e., further than the third amorphous ring in some cases. Their spatial frequency depended on the angle of overlay of the interfering beams, which was controlled by an electron biprism. From these interferograms, for the first time phase information of the amorphous structure has been obtained. The absolute phase may be able to be obtained using a microscope with multiple electron biprisms. An immediate application of the wavefront-splitting method is as a new method to measure the spatial resolution of the TEM, which occurs at the shear angle for fringe disappearance that is easily controlled using the electron biprism and measured by a Fourier transform showing realization from previous possibilities.

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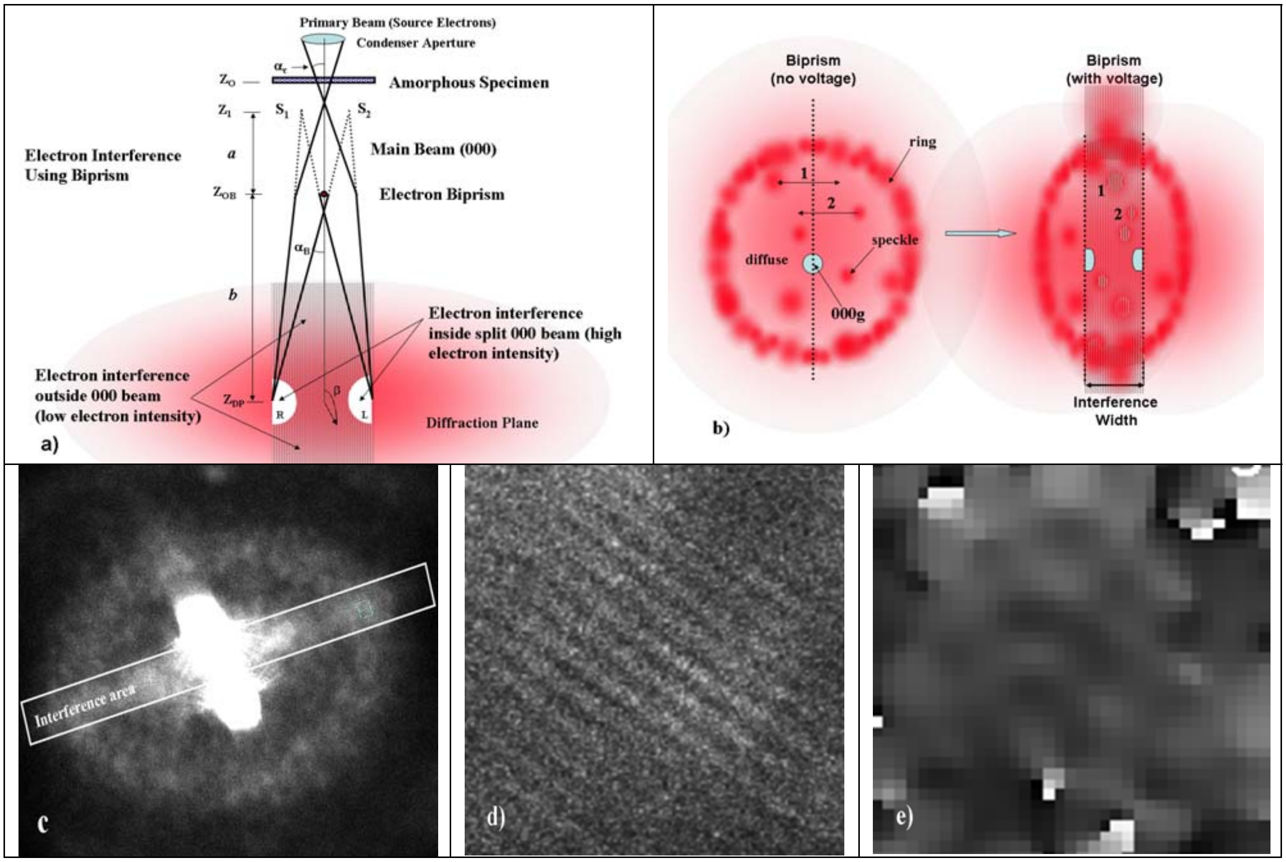

Fig. 1 – Wavefront-splitting interference on the diffraction plane showing in a) schematic, b) cartoon of intensities (mirror image not shown) and their interference, c) example interferogram from a-C, d) small area showing fringes and e) its reconstruction showing phase information showing possibilities of 3D for three biprisms.

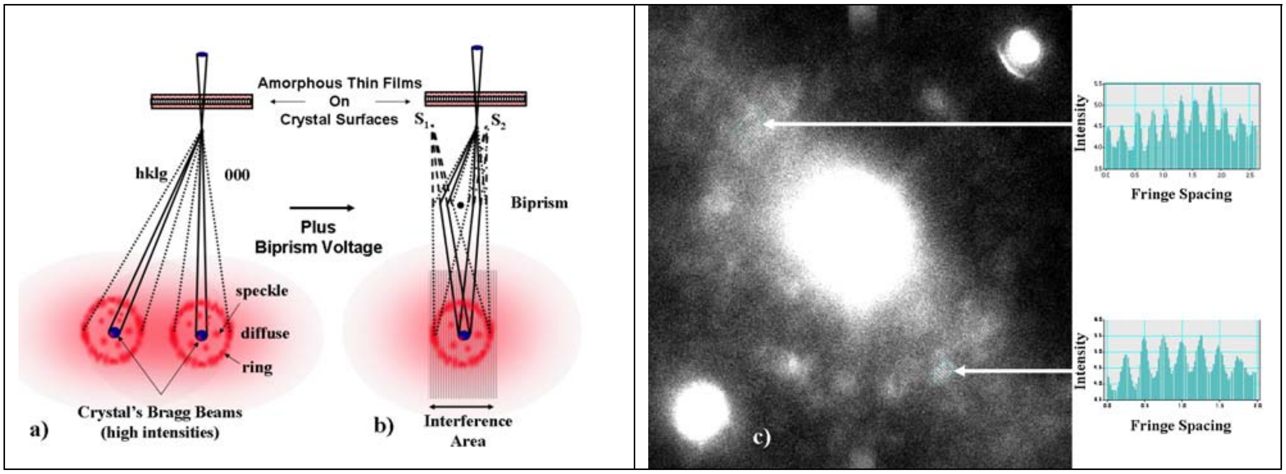

Fig. 2 – Amplitude-splitting interference on the diffraction plane showing in a) and b) the schematic of interfering amorphous intensities using crystal's Bragg diffracted beams and example in c) of GaAs.