Type of presentation: Poster

IT-1-P-1541 Investigation of physical and chemical method to produce Möllenstedt electrostatic biprism for off-axis electron holography experiment

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Denis Gabor has developed electron holography in 1948, as a method used to quantitatively retrieve the phase of the electron wave. D. Gabor proposed a configuration where the perturbed wave (object wave) and the reference unperturbed wave are observed in a common optical plane below the sample. In this plane a superimposition of the two waves can occur. This superimposition will induce an interference phenomenon and create the so-called in-line electron hologram, used to retrieve the phase difference between the two waves. In this configuration the sample is then out of focus. In 1955 G. Möllenstedt and H.Düker invented the biprism for electrons, a metallic wire biased relatively to the earth. The biprism effectively splits the electron beam into an object wave and a reference wave, which by electrostatic fields are brought to overlap onto one another. An interference pattern will be observed below the wire plane while the sample can still be in focus. This configuration, known as off-axis electron holography, is the one commonly used in all the major holography studies from dopant profiling to strain mapping through studies of nanomaterials magnetic configurations. Biprisms in common use today are constructed by coating ultrasmall quartz fibers with noble metals. The resulting biprisms, although they are quite small by most fabrication standards (approximately 700 nm in diameter), can have various mechanical, electrical, structural … properties. Depending on the quality of the biprism, the properties of the off axis hologram can be strongly modified. As an example, to avoid vibration, which drastically decrease the interference fringes contrast, the wire should be very taut; to minimize charge effect, which induce Fresnel fringes phenomena, the wire should be extremely clean; to increase the phase coherence of the beam across the biprism the wire should be the smaller possible, …

Regarding all these drastic requests that the wire should fulfilled to be a suitable biprism, the question of reproducibility become deeply problematic using standard biprism fabrication method. This question become even more crucial regarding our new microscope, the In situ interferometry TEM (I2TEM), a HF3300 TEM that fits with 4 biprisms wire used for various electron holography developments. In order to choose the most reproducible way which will give the best wire properties (size, vibrations, cleanliness, …), we have investigated several methods to produce them from chemical method to FIB (Focused Ion Beam) approach. The combination of these methods allowed us to make numbers of high quality biprism wire with a higher reproducibility rate.

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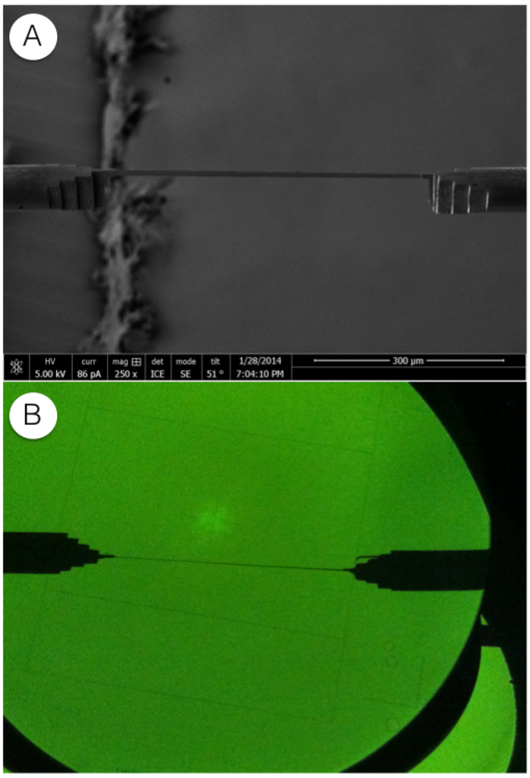

Fig. 1: A: SEM image of a Wollaston wire thinned using a FEI Helios FIB B: The same wire installed inside a Hitachi HF2000 TEM

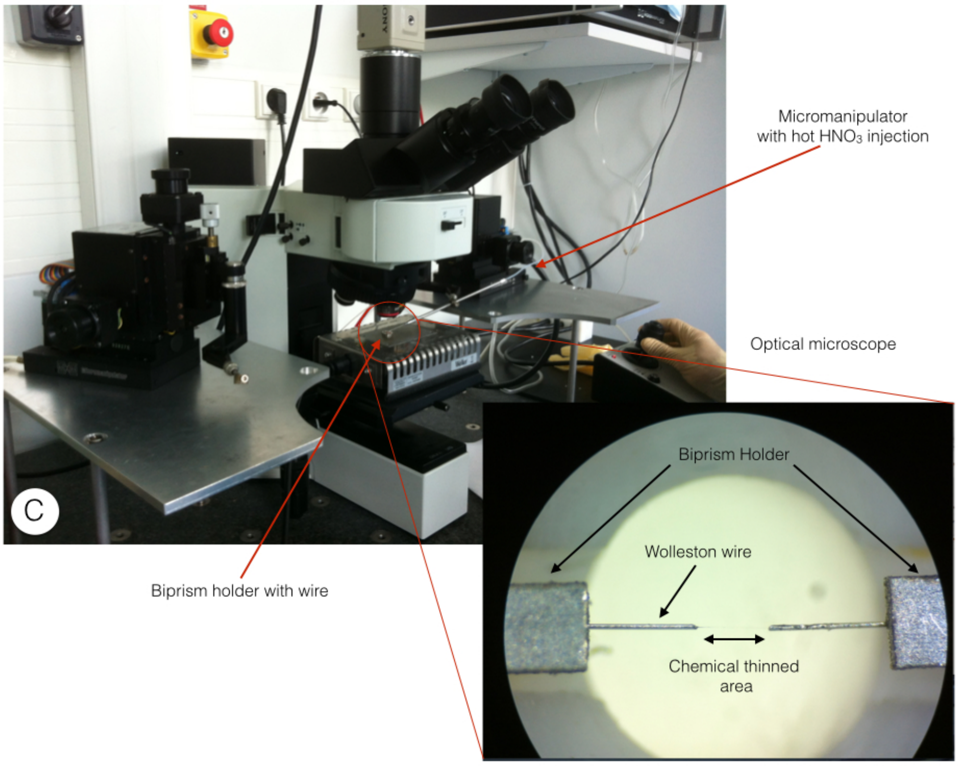

Fig. 2: C: Special and ultrafast chemical etching method using nanowetting of hot HNO3 onto a Wollaston wire