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Designing an Exchangeable Biprism for *In-Situ* Electron Holography

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Off-axis electron holography is a TEM technique that allows for imaging magnetic and electric fields in materials quantitatively with nanometer spatial resolution. As such, it would be attractive to use electron holography in combination with environmental TEM (ETEM) with great potential for various applications: E.g., studies on changes in magnetic structures under reduction/oxidation conditions, charge distributions in catalytic nanoparticles under the presence of various gases, and electric field distributions in working fuel cells.

The conventional biprism is designed for high vacuum and 'clean' conditions in a TEM column. The pressure in ETEM conditions is higher by six orders of magnitude than that in a normal TEM and a significant number of gas molecules exist in the TEM column. Therefore, the conventional biprism device may not survive for a long period and may be contaminated by residue gas molecules. For these reasons, an easily exchangeable biprism device, with a high stability and resistance against corrosive gases would be required. Therefore, we have designed and fabricated an exchangeable biprism device using MEMS-based fabrication technology.

Figure 1 shows a schematic design of a MEMS-based biprism chip, where an Au/Si biprism wire with a vacuum space on both sides of the biprism wire will be fabricated. The optimal dimensions of the biprism wire and the vacuum space was calculated using COMSOL modelling software in order to generate uniform electric fields, where 'two' electron beams are deflected towards one another for making an interference overlap region. The biprism chip is mounted on a home-made biprism rod, which is inserted into the selected-area aperture port of a microscope column (Fig. 2). The rod also holds two spaces for mounting selected area apertures. This biprism device is made without a rotational functionality to achieve better mechanical stability, which would be desired for *in-situ* high-resolution electron holography of catalytic nanoparticles under ETEM conditions.

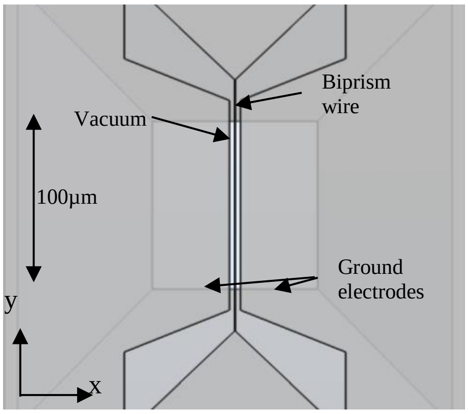

Figure 1: Design of the electron biprism chip.

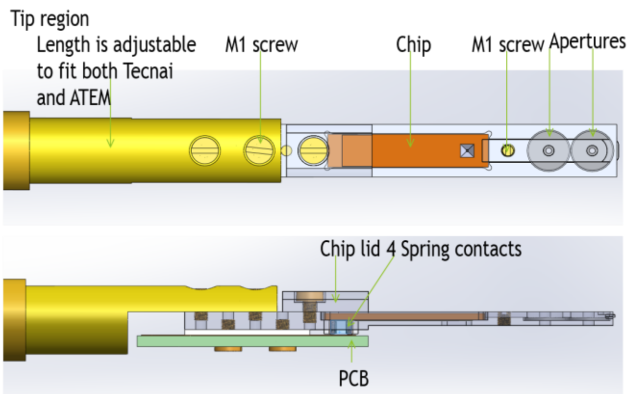

Figure 2: Schematic illustration of the electron biprism rod.