

APPLICATION NOTE

NCMN Central Facility for Electron Microscopy



TEM Specimen Tilting Holder

By Dr. X.Z. “Jim” Li, NCMN Specialist

Besides the standard specimen holder, a specimen tilting holder is also available for JEOL JEM-2010 and FEI Tecnai Osiris electron microscopes in NCMN CFEM. The tilting holder on the goniometer allows a TEM specimen to be tilted in two directions simultaneously. The specimen tilting holder is a key component for advanced transmission electron microscopy. In this application note, we introduce the usage of the TEM specimen tilting holder.

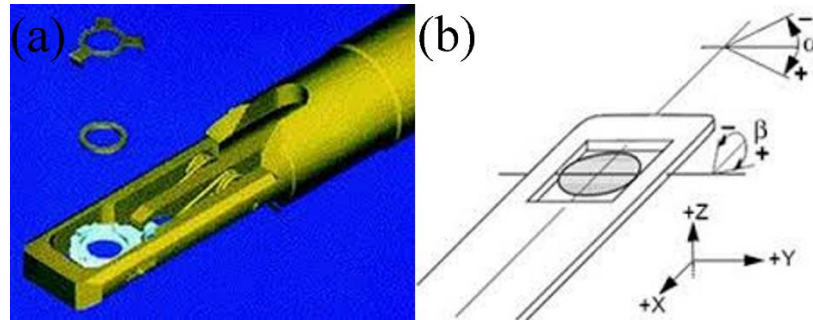


Figure 1. (a) Specimen tilting holder on FEI Tecnai Osiris S/TEM. (b) Schematic diagram of a specimen tilting holder. α is the tilt angle around the holder axis and β is the tilt angle around the orthogonal axis to the holder.

If the specimen is tilted from one position defined by the angles Φ_i and ξ_i , to another position Φ_j and ξ_j , the angle ε_{ij} between these two positions of the specimen is given by the following formula [1]:

$$\cos \varepsilon_{ij}(\xi, \Phi) = \cos(\xi_j - \xi_i) \cos \Phi_i \cos \Phi_j + \sin \Phi_i \sin \Phi_j$$

In the experiment, (i) make sure that the specimen is at the eucentric height before tilting it; (ii) figure out the relationship between the diffraction pattern changes and the tilting directions; (iii) keep the interesting area centered using

the shift x and y in imaging mode; (iv) record the diffraction pattern and tilting angles.

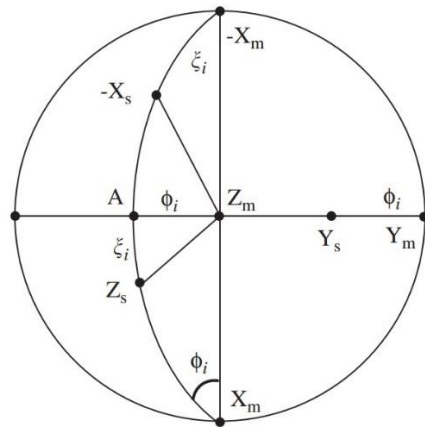


Figure 2. Stereographic projection showing the relative position of the electron beam and the specimen axes after a double tilt [2].

An example of electron diffraction patterns obtained on the intermetallic compound μ -HfCo [3] is shown in Fig. 3.

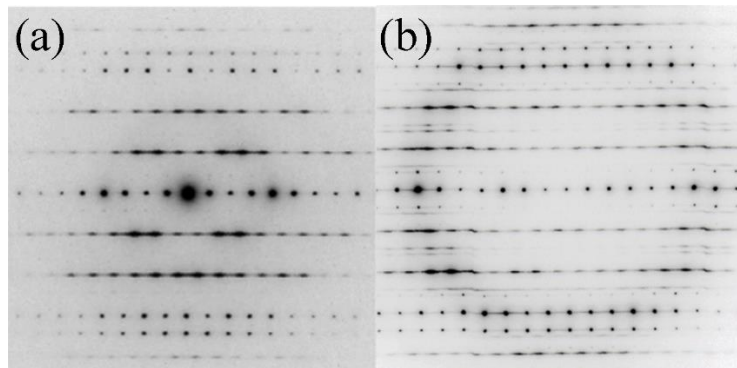


Figure 3. Selected area electron diffraction patterns of μ -HfCo phase, (a) exactly at [100] zone-axis and (b) tilted away about 1.2° with extinction spots.

[1] Kelly P.M., Wauchope C.J., Zhang X. (1994). Calculation of overall tilt angles for a double tilt holder in a TEM. *Microsc. Res. Tech.*, 1, 448-51.

[2] Zhao H.S., Wu D.Q., Yao J.C., Chang A.M. (2008). QtUCP—A program for determining unit-cell parameters in electron diffraction experiments using double-tilt and rotation-tilt holders, *Ultramicroscopy* 108, 1540–1545.

[3] Li, X.Z. *et al.* (2016). Electron diffraction study of the cobalt-rich Hf-Co intermetallic compounds. *J. Mater. Sci.* (submitted).