

Detection of Interstitial Atoms by Hollow-Cone Illumination HAADF-STEM

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High-angle annular dark-field scanning electron microscopy (HAADF-STEM), which provides Z-contrast images in atomic resolution, utilizes a conically converged electron fine probe [1]. In a zone-axis incidence, the electron beam predominantly channels through a certain atomic column (or deep potential) site rather than interstitial (or shallow potential) sites. As a result, HAADF-STEM is sensitive to the structures of the atomic column sites such as substitutional impurities [2] and chemical disorders [3], and is not so sensitive for detecting atoms located at interstitial sites and light atoms through which the incident electrons do not channel strongly.

In the present paper, we examine using Bloch wave calculations a possibility of HAADF-STEM for detecting interstitial atoms and light atoms by exciting "interstitial channelling" of the incident electron with a use of hollow cone illumination. We found that interstitial channellings are excited with certain hollow cone angles in low-order zone-axis incidences of silicon. HAADF-STEM experiments with the hollow-cone illumination is in progress.

[1] Pennycook S.J., Jesson D.E., *Phys. Rev. Lett.*, 1990, **64**, 938. [2] Voyles P.M., Grazul J.L., Mueller D.A., *Ultramicroscopy*, 2003, **96**, 251. [3] Kawasaki M., et al., *Philos. Mag. A*, 2001, **81**, 245.

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