Planar defects in diamond known as platelets on the {001} planes are found in type Ia diamonds which contain nitrogen impurities [1,2]. Humble proposed a model for the diamond platelet consisting of a double layer of carbon atoms [3]. More recently, Miranda and co-workers proposed a new model for the microscopic structure of platelets in diamond which forms by a shearing process [1]. The core of the platelet defect is a double layer of threefold coordinated \( sp^2 \) carbon atoms embedded in the \( sp^3 \) diamond matrix [1]. The model proposed by Humble [3] is one of the earlier carbon interstitial models favoured by Goss and co-workers [4].

It is the purpose of this paper to establish whether Cs-corrected high resolution (scanning) transmission electron microscopy (HRSTEM/HREM) imaging of platelets in type Ia diamond can determine which of the two models, Miranda and co-workers [1] or the earlier carbon interstitial model of Goss and co-workers [4], are in better agreement with the experimental results. HRTEM specimens were prepared by using a Helios Nanolab 650 focused ion beam (FIB) SEM and investigated in a double Cs-corrected JEOL JEM-ARM200F HRTEM.

Fig. 1(a) is a HRTEM image of a {001} platelet in diamond viewed edge-on. Fig. 1(b) and (c) show typical but different HAADF STEM images of {001} platelets viewed edge-on. The atomic structure of the {001} platelet model proposed by Miranda and co-workers [1] is different when viewed along the two perpendicular \(<110>\) directions. A similar type of inequivalence of the projected platelet structures along the \(<110>\) and \(<1-10>\) directions is present in the Humble [3] model favoured by Goss and co-workers [4]. Supercells containing the platelet defect in diamond (Fig. 2) were constructed using the atomic positions from the models of Miranda et al. [1] and Humble [3]. The difference in HAADF STEM platelet images of two different platelets shown in Fig. 1(b) and (c) is consistent with the platelet models shown in Fig. 2 when viewed along two perpendicular \(<110>\) directions. It is impossible to tilt the diamond foil through 90° in the HRTEM in order to image a {001} platelet along two perpendicular \(<110>\) directions, hence images of different platelets were recorded since it is likely that some will be viewed along the \(<110>\) and others along the \(<1-1 0>\) directions according to the indexing convention adopted by Miranda et al. [1] and Goss et al. [4] and shown in Fig. 2. Comparisons of HRTEM/HRSTEM images and image simulations of the platelet models shown in Fig. 2 will be presented.

References

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Fig. 1: (a) HRTEM image of a {001} platelet in diamond viewed edge-on. (b) and (c) show typical but different HAADF STEM images of {001} platelets viewed edge on. Beam direction = \(<1\bar{1}0>\). Scale bar: 1.26 nm

Fig. 2: Supercells containing the platelet defect in diamond constructed using the atomic positions from the models of Miranda et al. [1] (a and b) and Humble [3] (c and d). The vertical direction is \(<001>\) for all the platelets and the viewing directions are \(<1\bar{1}0>\) for (b) and (c), and \(<1\bar{1}0>\) for (a) and (d).