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Growth and crystallographic features of interpenetrant twins in natural diamonds

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Abstract

The different morphologies of diamond crystals reflect the growth conditions and provide valuable information about the processes that led to the formation of the diamond. Diamond twins only occur during growth and only through reticular merohedry, which has a significant effect on the physical properties of the diamond. However, due to the scarcity of samples, particularly samples with interpenetrant twins, few investigations have been conducted on their morphological features and related formation mechanisms. In this study, natural diamonds with interpenetrant twins from the Republic of the Congo were analyzed to investigate the crystallographic features and related growth formation mechanisms using scanning electron microscopy and micro-computed tomography. The results reveal that all the samples exhibit cubic habits with deformation and a rough appearance, accompanied by fibrous growth layers, indicating rapid crystallization under high driving force conditions. Based on the different features of the crystals' macroscopic morphological properties, three types of theoretical twin models are established. Cathodoluminescence imaging shows that there are two patterns regarding the formation of interpenetrant twins in natural diamonds, including the origination of grains during the nucleation stage of crystals in the form of twinned positions and changes in the orientation of the growth layer arrangement during crystal growth. Moreover, a mixed type of twin structure was observed, indicating the complexity of the diamond twin growth process, involving transformation of the crystallization habit of the crystal.

Keywords: Diamond, interpenetrant twins, crystal morphology, surface microtopographic features, formation