CHAPTER VII

ELECTRON OPTICAL STUDIES OF TRIGONS

7.1 Introduction

In the work described in the earlier chapters, mainly the optical microscopy, the phase contrast microscopy and high resolution multiple beam interferometry have been used for the studies of the trigons and other microstructures on the various faces of natural diamonds. The phase contrast microscopy and multiple beam interferometry have good resolution for studying surface features in depth but not in extension. It was therefore decided to make a critical examination of the trigons on the octahedral faces of diamond in transmission electron microscopy which has good resolution in extension so that this study may throw some more light and help in revealing the truth about their origin and hence the history of growth of the crystal.

Tolansky (1955) has reported that some trigons have characteristic basal projections known as basal extensions. These have not been investigated fully. Another important feature which has escaped critical examination is the structure of the point-bottomed trigons. It was felt that these two are the diagnostic features in revealing the origin of trigons and hence they have been critically studied in the work described in this chapter.

7.2 Observations

Figures 68 (X 3000), 69 (X 3000) and 70 (X 3000) represent the electron micrographs of the natural (111) face of a macle obtained from a single stage carbon replica shadowed with chromium. In order that the shallow features may also be revealed, shadowing was done at a small angle of 25^{o}. It is clearly seen in these figures that the trigon patterns have been fully resolved. The trigons in these patterns possess all the characteristics described about them by Tolansky (1955). Attention may be drawn particularly to the basal extensions associated with a good number of trigons observed in figures 68, 69 and 70. It appears that the basal extensions are associated with those trigons which appear to have been formed within the larger ones. That in fact it is so, is clearly revealed from the electron micrographs shown in figure 71 (X 16750) and figure 72 (X 7500). In figure 71, it is seen that a number of smaller trigons have appeared within a larger trigon which does not appear to be well defined as some portions of its sides are missing; may be due to interference from the neighbouring trigons. In addition to the smaller trigons there are still smaller trigons which have just made contact with the neighbouring trigon or yet not made any contact. These smallest trigons appear to be without any basal extensions. This is clearly seen in figure 72. Attention may be drawn to the fact that the smallest trigons which are point-bottomed have their bottoms eccentric. Figure 73 (X 37500) is a very good example in which the eccentricity of the point--bottomed trigons is clearly revealed. So far, studies have been made on trigons which are equilateral. Figures 74 (X 7500) and 75 (X 7500) represent electron micrographs of (111) face showing some isosceles trigons while in electron micrograph shown in figure 76 (X 7500), some scalene trigons can be clearly seen. It may be mentioned that all these trigons whether isosceles or scalene have characteristics similar to those of equilateral trigons described by Tolansky (1955) except that their sides and angles are not equal.

7.3 Discussions

If it is assumed that trigons have been formed due to growth by sweeping round a linear barrier (Halperin, 1954) of growth layers proceeding in one direction, it is difficult to explain the formation of trigons within the trigons. In case the trigons are formed due to growth then the inner trigons must have been nucleated earlier, i.e., they must be older in age as compared to the large trigons in which they are found. In this case it is difficult to conceive the following :

(1) How the barriers which give rise to the larger trigons are always of the proper size and situated at the proper place so that the trigons formed by sweeping around them have sides exactly touching the sides of the smaller trigons within them and they never cross the smaller trigons ?

(2) Why the boundary of the outer trigon which is comparatively younger than the inner ones should not be complete and perfect ?

(3) Why should the basal extensions be associated with some trigons which are situated within a larger trigon ?

(4) Why the smallest trigons which are observed within the larger ones have no basal extension ?

If on the contrary it is assumed that the trigons are formed due to a dissolution process in nature, the observed facts can be easily explained. In this case the larger trigons must have been nucleated earlier and hence are older in age as compared to the smaller trigons found within them. The explanation is as follows :

(1) Trigons formed due to dissolution nucleate at dislocations. In the process of dissolution when they grow bigger, if another dislocation is exposed within the trigon, another trigon will start growing within the first one. In this case there is no question that the sides of the bigger trigon will cross over the smaller one. Thus the formation of trigons within the trigons can be explained.

(2) Since the age of the outer trigons is more than that of the inner ones, their boundaries may be affected by dissolution due to the neighbouring trigons and thus they may appear incomplete.

(3) It can be clearly observed in figure 71 that the basal extensions are nothing but the reminiscence of the boundaries of the outer trigon which have partly disappeared.

(4) The smallest trigons which are isolated should necessarily not have any basal extensions as they have not interfered with the neighbouring trigons.

It thus appears that if trigons are assumed to have been formed due to dissolution all the observed features are well explained. This is also supported by our observations that the point bottoms of the point-bottomed trigons are eccentric. It is in fact difficult to imagine how a point-bottomed trigon can be formed due to growth in which layers are deposited one above the other. It is even more difficult to imagine how an eccentric point-bottomed trigon can be formed due to growth, while it is very easy to explain how it happens in the process of dissolution. During the process of dissolution the bottom of the pit follows the linear defect at which it has been nucleated and hence if the dislocation line is inclined to the surface undergoing dissolution the pit with eccentric point-bottom will result. In some cases it has also been observed that a trigon divides into two or more trigons. This can be explained if the trigons are assumed to be etch pits nucleated at dislocations in the crystal.

The formation of the isosceles and the scalene trigons can also be very easily explained by the process of dissolution rather than by the process of growth. This may be due to the fact that the surface in this region may not be true (111) surface but a vicinal plane inclined at a very small angle. Patel (1957) has reported the formation of deformed triangular pits nucleated on the vicinal faces, forming the trigons.

Thus the author agrees that the trigons are formed due to some linear imperfections in the crystal lattice but the process by which they are formed is the dissolution process and not the growth process.

Conclusions drawn from these studies are in confirmity with those described in the earlier chapters.