EFFECT OF SUPERSATURATION ON THE ACTIVITY OF GROWTH CENTERS

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Abstract

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EFFECT OF SUPERSATURATION ON THE ACTIVITY OF GROWTH CENTERS

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Until now there have been no experimental works confirming the theoretical conclusions of F. Frank, W. Burton, and N. Cabrera that each value of supersaturation must correspond to its own growth center. Such a study was carried out by us on an apparatus for observing the growth of crystals under a microscope ([1]). The tetrahedral face of $NaBrO_3$ crystals was investigated under a steady-state growth regime. Observations were conducted in reflected light with simultaneous filming of the growth process. The filming interval was 72 sec. A seed of size 1–2 mm grew at a temperature of +40° under different supersaturation conditions: $\Delta C = 0.001$; 0.003; 0.005, which corresponds to supercooling of 1.5; 4.2; 6.8°. Every 15–30 min., the supersaturation regime was changed by changing the temperature. The accuracy of maintaining the temperature in the solution was ±0.017°. The sequence of supersaturation changes was as follows: 0.001–0.003–0.001–0.003–0.001–0.003–0.005–0.001.

The morphology and kinetics of shock waves of step density arising at the growth center were discussed earlier. Here we shall dwell on the evolution of growth centers as a function of supersaturation.

It turned out that when the supersaturation is changed, the growth center loses its activity and yields the leading role to another center, and when the initial supersaturation is restored it again assumes the formation of shock waves. In Fig. 1 A the most active is the growth center marked by the arrow. The layers emanating from it cover the greater part of the face. To the right of it, concentric shock waves of another growth center are clearly visible; at a supersaturation of 0.003 this center begins to suppress the first growth center. With the subsequent transition from 0.003 to 0.001 it is seen that the right-hand growth center has ceased to generate shock waves, and the boundary between the "spheres of influence" of the left and right growth centers begins to move to the right (cf. Fig. 1 B and 1 C). If growth of the seed at a supersaturation of 0.003 lasts about 30 min., then the growth cone covers the entire surface of the face (Fig. 1 D), with the same growth center being active here as at the other stages of the experiment at a supersaturation of 0.003. Further lowering of the supersaturation again leads to a loss of activity of the right-hand growth center and to expansion of the left growth cone (active at 0.001, Fig. 1 D). At a supersaturation of 0.003 the right-hand growth center again becomes active.

Figure 1

Figure 1: Figure 1

Increasing the supersaturation to 0.005 causes the preceding growth centers to fade completely, and the initiative passes to an entirely new growth center that has arisen near the lower right edge of the crystal (Fig. 1 E). The region encompassed by this growth center expands very rapidly. It generates very high shock waves, which obscure the previous growth centers to such an extent that upon the subsequent lowering of the supersaturation to 0.001 they no longer manifest themselves, and the initiative passes to a new growth center. Attention is also drawn to the fact that, in the process of changing the supersaturation regime, up to 10–15 growth centers appear on the surface of the face; these are soon suppressed by the growth center active under the established supersaturation regime.

Thus, as F. Frank ([2]) rightly pointed out, each value of supersaturation corresponds to its own group of dislocation offsets in the crystal, and a change in supersaturation must change the dominating group (the center of the growth pyramid). An explanation for this can be found from those

Fig. 1. A –supersaturation $\Delta C = 0.001$; –transition from $\Delta C = 0.003$ to $\Delta C = 0.001$; $-\Delta C = 0.001$; $-\Delta C = 0.003$; $-\Delta C = 0.001$; $-\Delta C = 0.005$. White spots are reflections of light from the bottoms of buried inclusions. 32×

conclusions of the dislocation theory of crystal growth ([3]), in which it is indicated that only those groups or pairs of dislocations can be active for which the distance between them does not exceed the diameter of the critical nucleus. The magnitude of the critical nucleus, however, does not remain constant when the supersaturation changes.

Thus, the experimental material obtained by us agrees well with the dislocation theory of crystal growth.

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REFERENCES

[1] T. G. Petrov, *Kristallografiya*, **2**, No. 6 (1957).
[2] F. K. Frank, *New Studies in Crystallography and Crystal Chemistry*, **1**, Moscow, 1950, p. 56.

[3] W. Burton, N. Cabrera, F. Frank, *Elementary Processes of Crystal Growth*, Moscow, 1959, p. 51.

Note: Figure translations are in progress. See original paper for figures.