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The reduction of the crystalline perfection of graphite by grinding.

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In an earlier note (Bacon, 1950) the writer has described the increase in the proportion of rhombohedral modification during the process of grinding samples of well-crystallized graphite. At the same time it was noted that there was line broadening of high-angle reflexions, which might be due to increasing disalignment of layer planes during the disturbances taking place in the structure.

During further investigations it has been noticed that with continued grinding, of both natural and artificial specimens, a steady deterioration of the crystalline perfection can be clearly followed. Fig. 1 shows the variation with time of grinding of H, the overall height of the parallel stacks of layers (both oriented and disoriented); of L, the diameter of the layer planes; and of p, the probability of layer displacement. These quantities were calculated from the line widths and shapes of the 0004, $11\bar{2}0$ and $11\bar{2}2$ lines respectively, using Cu $K\alpha$ radiation and a 19 cm. camera. The measurements were made with a sample of electric-furnace graphite, for which the initial p value was 0·2, representative fractions being extracted from a ball mill after various periods of grinding.

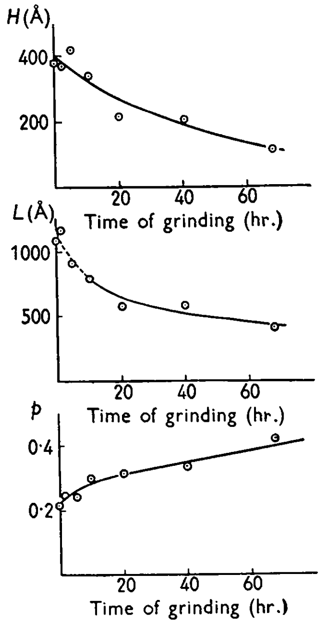

Fig. 1. Electric-furnace graphite: reduction of crystallite size and perfection by grinding.

For simplicity no mixture substance was used for the line width determinations, the samples being merely extruded to identical diameters and examined under nominally identical conditions. Correction was made for geometrical broadening, on the basis of Jones's (1937) method, using a similarly prepared specimen of highly crystalline graphite. Linear, rather than integral, breadths were measured and it is likely that the absolute values of H and L are not as accurate as could be obtained by a more lengthy investigation.

It is interesting to note that a sample of natural Ceylon graphite, for which a p value of 0·05 may be taken as representative of its crystalline perfection (Bacon, 1951), may be degenerated to the condition of a normal electric-furnace graphite, with $p = 0{\cdot}2$, by continued grinding. This is illustrated in Fig. 2, which is reproduced from portions of the photometer records (plotted simply as transmitted light) of the diffraction patterns of the natural graphite, before and after 68 hr. grinding, and of the electric-furnace graphite as normally used. The detail of the second and third pattern is very similar, showing, relative to the first pattern, the decrease of L (giving a small increase in the width of $11\bar{2}0$), the decrease of H (with increased width of 0006), and the increased value of p, leading to increased width of the $11\bar{2}2$ and $11\bar{2}4$ lines and effective disappearance of $10\bar{1}5$ and $20\bar{2}3$.

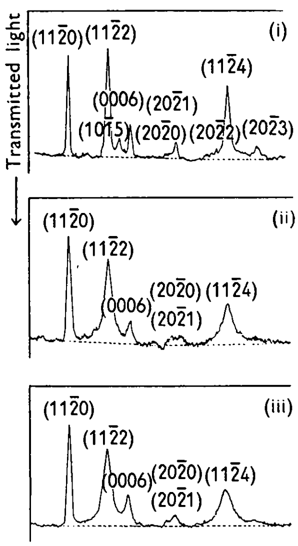

Fig. 2. Comparison of photometer records of (i) natural graphite, (ii) natural graphite after 68 hr. grinding, (iii) electric-furnace graphite, $p = 0{\cdot}2$.

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