THE INFRA-RED ABSORPTION BY DIAMOND AND ITS SIGNIFICANCE

Part III. The Perfect Diamonds and Their Spectral Behaviour

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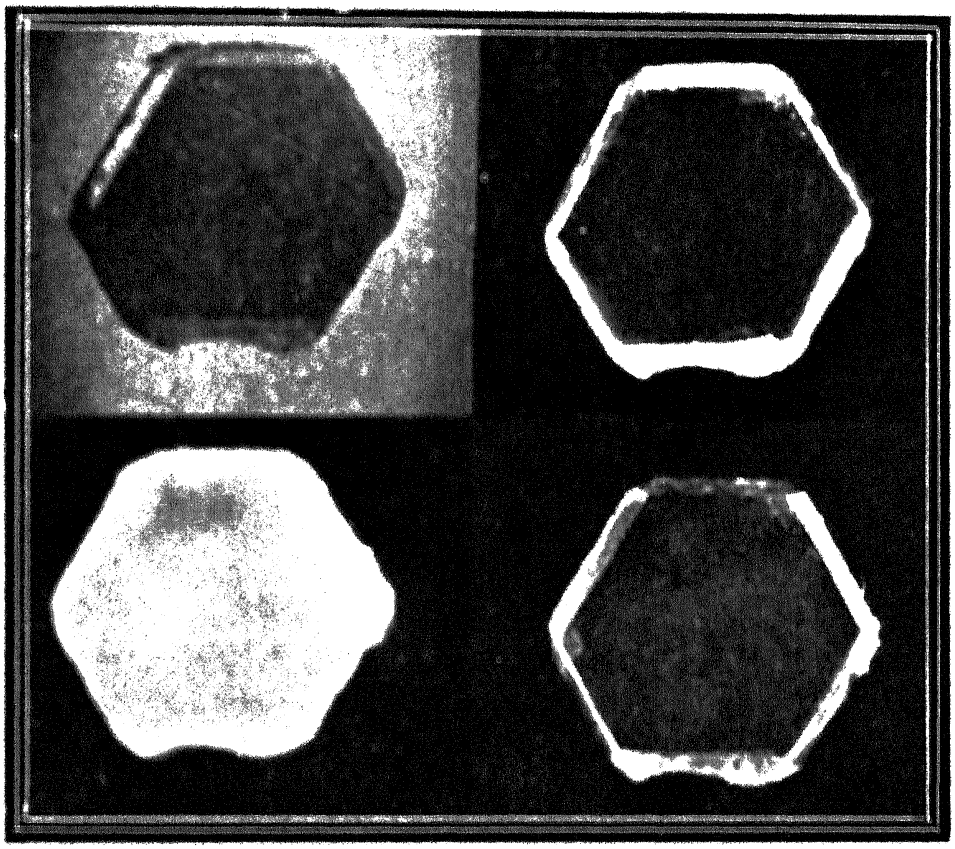
1. INTRODUCTION

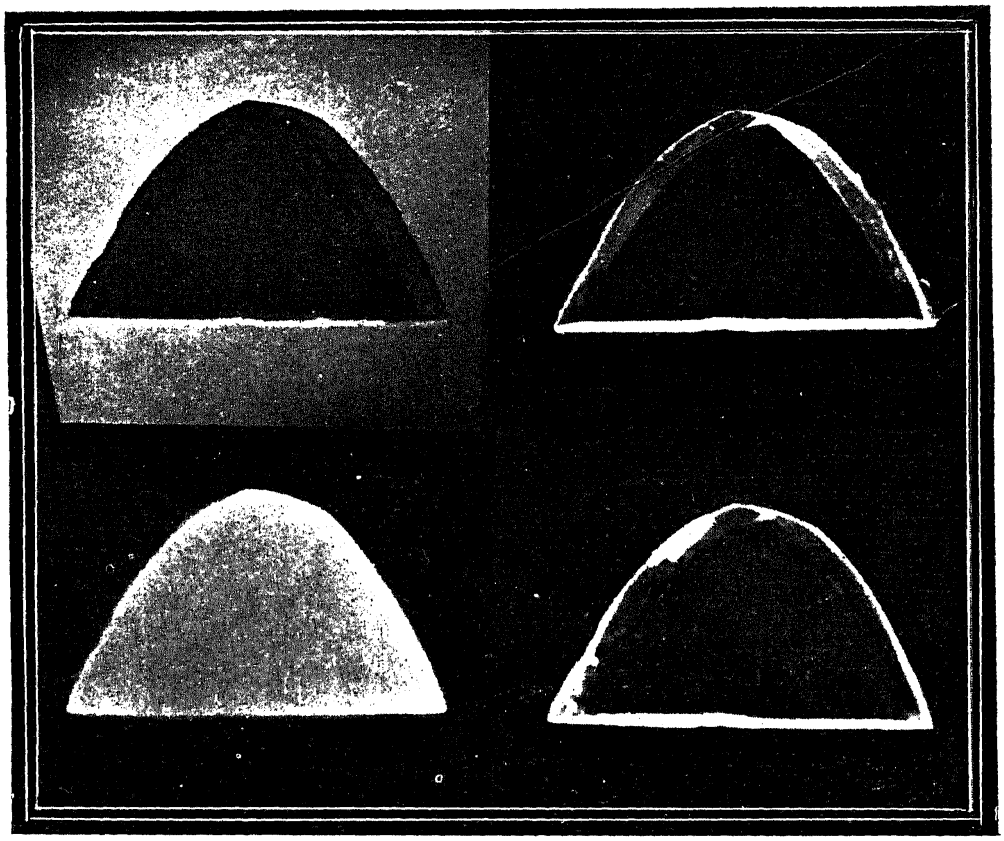
A PERFECT diamond should be colourless and transparent and should be free from internal cracks and inclusions and should further exhibit no visible birefringence when placed between crossed polaroids and viewed against a bright source of light. This last test is a stringent one and it serves to exclude a large majority of diamonds. The specimens that do satisfy the test also exhibit the other properties characteristic of the group A diamonds described and illustrated in the second part of this memoir. We shall in the present part deal a little more fully with their optical characters and especially with their infra-red behaviour.

A fine example of a perfect diamond is the tabular crystal in its natural hexagonal form which was presented to the author by the late Dr. Paul Grodzinzki. Photographs of this diamond obtained by four different techniques are reproduced in Plate II. The picture marked (*a*) was obtained with the diamond placed on a fluorescent plate and illumined by the $\lambda 2536{\cdot}5$ radiations of a mercury arc which traversed the diamond before reaching the plate. The photograph exhibits the opacity of the diamond to the radiations. The photographs marked (*b*) was obtained with the diamond held between crossed polaroids and exhibits its perfect freedom from birefringence. The photographs marked (*c*) and (*d*) were obtained with the diamond illuminated by sunlight filtered through a plate of Wood's glass. Photograph (*c*) exhibits the faint blue luminescence of the diamond as seen through a filter of blue glass. The exposure was so prolonged that the luminescence was recorded with great intensity. Photograph (*d*) represents the luminescent diamond in the same circumstances as viewed through a filter of yellow glass. It will be noticed that the luminescence is then unobservable.

The photographs reproduced in Plate III and marked (*a*), (*b*), (*c*) and (*d*) were obtained using similar procedures with a cleavage plate of diamond



(a) (b)



(c) (d)

A Perfect Diamond (cleavage plate)

of Indian origin. It will be noticed that the effects exhibited by it are in each case similar to those seen in Plate II.

2. Characteristic Features of the Absorption

In the first part of this memoir, reference was made to the desirability of recording the transmission curves with the Leitz instrument at a very low speed. The importance of this remark is illustrated by Fig. 1 in the text below which is the record in the 2μ–12μ region obtained with a perfect diamond 0·81 millimetre thick, the speed of recording being at the rate of 10 minutes per μ of wavelength. A comparison with the record of another diamond of the same class but recorded at a speed of 3 minutes per μ and reproduced as Fig. 1 in the second part of this memoir shows that the slower speed greatly improves the sharpness and precision of the recording. This is especially evident in the region of wavelengths between 7μ and 10μ where the features exhibited by the perfect diamonds make their appearance and which we shall now proceed to discuss.

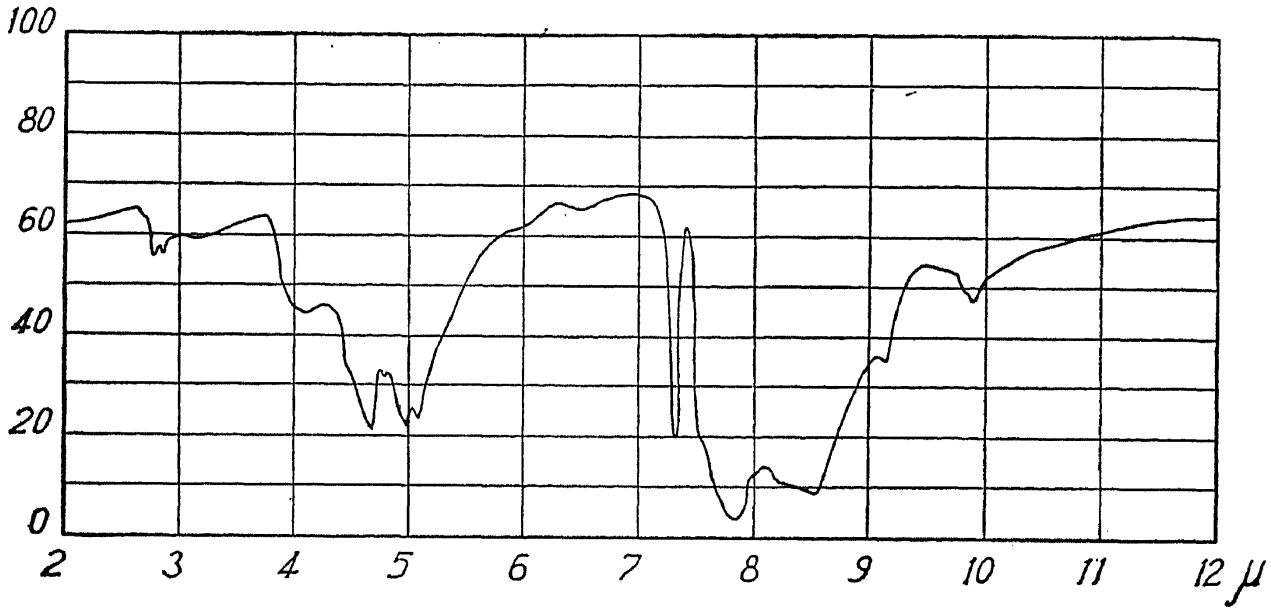


Fig. 1. Percentage Transmission Curve of a Perfect Diamond: (Thickness 0·81 millimetre).

A very remarkable feature of the absorption spectra of the perfect diamonds is the sudden increase in absorption which appears between $7{\cdot}4\mu$ and $7{\cdot}5\mu$. This is very clearly shown in Fig. 1, the transmission falling from 62 to 20% within a range of only $0{\cdot}1\mu$. The curve coincides with the $7{\cdot}5\mu$ ordinate in the region where the transmission falls from 40 to 20% and then suddenly alters its course. The sharp absorption edge at $7{\cdot}5\mu$ (or in wave-numbers 1332 cm.$^{-1}$) is thus a highly characteristic feature exhibited by the perfect diamonds. It is well known that in the spectrum of the scattering of light by diamond, a sharply defined frequency shift of 1332 cm.$^{-1}$