Note on synthetical corundum and spinel.

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DURING recent years a considerable industry has grown up at Paris in the synthetical manufacture of corundum for jewellery purposes by means of the process devised by Professor A. Verneuil.[1] In place of the fragments of natural ruby used in previous attempts, ammonium-alum is the material employed. After careful preparation to free it from potash and other impurities, it is ground to a powder and placed in a sieve at the top of the oxygen tube of an inverted blowpipe. The sieve is tapped by a hammer at regular intervals, and uniformity is in this simple way produced in the amount of powder that falls; the necessary adjustment is effected by varying the height through which the hammer falls. To minimize the cost of production, a few alterations have been made in the original apparatus. The hammer is no longer actuated by the make and break of an electro-magnet, but is directly operated by a cam, and for further simplicity the cams of several machines are worked by the same shaft. Coal-gas has been substituted for hydrogen, and has been found equally effective. The process is now so simple that one man can look after a dozen or more of these machines.

As soon as the powder reaches the orifice of the pipe, the ammonium volatilizes in the flame, and the alumina falls as a liquid drop on to a narrow pedestal of previously fused alumina. By turning a screw which lowers this pedestal the operator causes the alumina mass—'boule,' as it is termed by the French jewellers—to grow upwards. The pressure of the effluent gases is kept low at first lest the pedestal be melted, and is afterwards gradually increased so that the growing mass takes the shape of a pear. The orifice is carefully jacketed to prevent too sudden cooling of the drop and consequent disastrous flaws.

[1] A. Verneuil, 'Mémoire sur la reproduction artificielle du rubis par fusion.' Annales de chimie et de physique, 1904, sér. 8, vol. iii, pp. 20–48; also reprinted with separate pagination, Paris, Gauthier-Villars, 1904, pp. 1–30. An abstract appeared in La Nature, Paris, 1904, vol. xxxii, pp. 177–178.

It is, indeed, a most surprising fact, as was pointed out by Professor G. Wyrouboff,[1] who examined some of the early specimens, that these drops have a homogeneous crystalline arrangement and are not, as might have been anticipated, an alumina glass or an irregular aggregation of crystalline fragments. The principal crystallographical axis is parallel to the core of the pear, if the drop has been properly prepared. The surface at the side is clear and vitreous in lustre, but shows horizontal striae due to slight variation in the density of the colouring matter. The broad end likewise becomes clear and vitreous if allowed to remain in the flame, but this does not as a rule happen, since for the sake of economy the gases are cut off as soon as the drop is large enough. When the end is rough, examination with a lens shows that it is covered by a fine network of lines mutually intersecting in angles of apparently 60°. To see what relation the network bore to the crystallographical constitution, I placed a well-formed drop on a goniometer, and found that the reflections obtainable corresponded exactly in position to the faces of the fundamental rhombohedron, $r=(100)=(10\bar{1}1)$, of corundum. I may also mention that the apex of the pear which is broken on removal from the pedestal sometimes shows a good plane of parting parallel to the basal plane.

These drops are colourless, or, if not quite free from potash, slightly brownish in tint. The particular hue known as pigeon's-blood red is obtained by the addition of sufficient chrome-alum to give 2½ per cent. of chromic oxide in the fused mass. With a smaller quantity, pink stones have been produced; from their similarity in colour to the so-called 'burnt' topazes, the original colour of which has been altered to pink by the application of heat, they have been most unhappily termed in the jewellery trade 'scientific topazes'.

Since the stones thus synthetically formed have the actual structure of natural corundum, it necessarily follows that they possess all its physical characters—refractive power, double-refraction, dichroism, hardness, &c.—and that they cannot therefore be distinguished from it by any of the ordinary tests. Experience, however, has shown that these stones, as at present manufactured, are never free from included air-bubbles and curved striae, and thus they may easily be discriminated upon examination with a microscope or a lens. In natural corundum the cavities are negative crystals and have plane sides, and the striae are straight.

It is not a little surprising that all efforts to impart to these syn-

[1] See memoir mentioned in preceding footnote, pp. 25-27 of the reprint.

thetical stones a blue colour, and thus to obtain sapphire, have as yet been attended with failure. At the end of October, 1907, I received from Mr. E. Hopkins, 58 B Hatton Garden, London, E.C., a specimen, in the familiar pear-shape, of what is termed by American jewellers 'Hope sapphire', presumbly from fanciful analogy with the famous blue diamond. Mr. Hopkins had himself detected that it lacked the dichroism of sapphire, and in hardness lay between sapphire and topaz. From an observation made with a refractometer upon a small polished facet, I determined the refractive index for sodium-light to be 1·727, and on placing the specimen between crossed nicols found that it had no action upon polarized light. Further, I noticed that the fine network of lines covering the broad end of the pear mutually intersected at right angles at the top, the angle diminishing to 60° at certain regions of the sides. Goniometrical examination showed that the reflections corresponded mainly to the faces of the octahedron, and in a lesser degree to those of the cube, the crystallization being cubic. The obvious conclusion that these blue stones are synthetical spinel was confirmed by Dr. G. T. Prior, who found by a qualitative chemical examination that they consisted of alumina and magnesia with a trace of cobalt.