HEMATITE AND RUTILE FORMED BY THE ACTION OF CHLORINE AT HIGH TEMPERATURES

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The crystals described in this note were formed in the course of some experiments on the volatilization of iron from clay pots used for the melting of optical glass. In order to reduce the amount of iron introduced by solution of the pot walls, experiments[1] were made on the removal or iron from the pot itself by the action of chlorine at the temperature of the pot arch (1000 to 1100° C.). Chlorine was led into the suitably covered pot for several hours. In some preliminary experiments the pot was removed from the furnace immediately after the chlorine treatment and a deposit of crystals of hematite was found on the outer upper portion of the pot, where the effluent chlorine and ferric chloride vapor had come into contact with the products of combustion, which filled the (gas-fired) furnace. On the inside of one of these pots minute glittering crystals were found which subsequently were identified by chemical, optical, and crystallographic characters as rutile, one form of titanium dioxide.

The hematite crystals, which had a maximum diameter of 4 mm., were tabular parallel to the base. The rhombohedron, $r\{10\bar{1}1\}$, and the diagonal pyramid, $n\ \{22\bar{4}3\}$, were also present on all the crystals. Most of the faces on three crystals measured were very perfect. Variations of only 2′ from the mean were found in readings $c:r$ and $c:n$, the average values of which were 57° 37′ and 61°13′ respectively. These are the values accepted by Dana for natural crystals. The magnetic properties of the crystals indicate the presence of not more than 0.2 per cent. of ferrous iron.

The formation of hematite from vapor containing ferric chloride has been mentioned many times in the literature.[2] The crystals described are similar to natural hematite, but both natural and artificial have a somewhat variable axial ratio. The

[1] Hostetter, Roberts and Ferguson, *J. Am. Ceram. Soc.*, **2**, 356–372 (1919).

[2] See bibliography previous to 1891, together with notes by Arzruni: *Z. Kryst. Min.*, **18**, 46, 1891. Fearnsides has described crystals which form when the vapors developed in the coking of salty coal meet the atmosphere: *Trans. Engl. Ceram. Soc.*, **17**, 340, 1918. (Discussion).

effect of ferrous oxide in changing the ratio cannot be determined from the data at hand. Perhaps the largest hematite crystals which have been noted were those formed in iron pipes used in the Deacon process for chlorine. These were mentioned by C. E. Munroe[1] and have recently been analyzed and studied magnetically.[2] They do not, however, have good faces.

The rutile crystals were less than 1 mm. long and so thin that they showed the brilliant colors of thin films. The perfection of their outlines and twinning is shown in Fig. 1. The crystals shown at the ends are twinned on *v*, and the other on *e*.

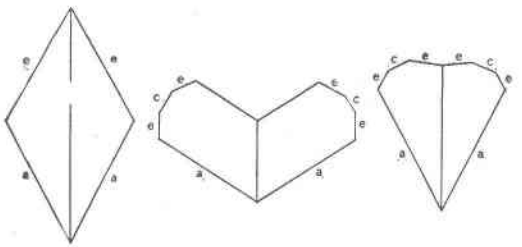

FIG. 1. RUTILE FORMED AT 1000° C.

All three crystalline forms of titanium dioxide have been prepared artificially from vapors containing titanium chloride.[3]

It is desirable sometimes to have large, well-developed crystals for research work. The process above described suggests immediately that crystals of hematite and rutile might be grown by the action of water on the vapor of the chlorides of the metals, in a silica glass container maintained at a temperature of 1000° by an electric furnace. Furthermore, it seems feasible to grow crystals of hematite containing ferrous oxide in solid solution. The angles of such crystals would be expected to show interesting variations.

[1] *Am. J. Sci.* [4], **24**, 486, 1907.

[2] Sosman and Hostetter, *Trans. Am. Inst. Min. Eng.*, **58**, 409–433, 1917.

[3] Daubrée, *Compt. rend.*, **29**, 227, 1849; Deville and Caron, *Compt. rend.*, **53**, 161, 1861; Hautefeuille and Perry, *Compt. rend.*, **110**, 1038, 1890.

From German journals which have been held in England during the war but are now gradually arriving in this country we learn of the death of Professor Max Bauer, of Bonn, on November 4, 1917.