nate. In carefully conducted oxidations in the course of the transformation an extremely unstable intermediate product, which is difficult to isolate and which is probably the ketonic acid derived from methyliridinic acid, $C_6H_2(OCH_3)_3COCO_2H$, and which we have not followed further.

(*To be continued.*)

ON CARBORUNDUM.

(CARBIDE OF SILICON.)

BY DR. OTTO MÜHLHAEUSER.

THIS new material stands next to diamond, not only in its composition, but in its internal and external properties, in the extraordinary brilliancy of its crystals, and in the extreme hardness which makes it such an efficient and powerful abrasive material.

It is an American invention, having been discovered by Edward G. Acheson, of Monongahela City, Pa., who carried the invention to commercial success with extraordinary energy in the face of many obstacles.

The product is obtained by heating a mixture of 100 parts sand, twenty-five parts salt and twenty-five parts coke in an electrical furnace for several hours. The alternating current used has finally a strength of about 500 amperes and a difference of potential of fifty volts.

The mixture yields a mass in which we can distinguish shells and layers of different character and nature. Around the carbon core we find a layer of graphite. The latter is surrounded by a thick shell of carborundum crystals. This shell of carborundum is enveloped in a thin sheet of amorphous carbide of silicon; surrounding and incasing these three products of the reaction is the original mixture in an essentially unchanged condition.

(1) *The Graphite.*—The graphite is located around the carbon core and is covered by the carborundum crystals. It is connected with the latter, forming one large elypsoid of crystals whose rays are arranged radially to the axis of the elypsoid or

core. The inner part of this shell contains the black graphite crystals, the outer the carborundum.

Those parts next to the core consist of pure carbon, and possess all of the properties of graphite—blackening the fingers with metallic luster, feels soft, unctuous, etc. These graphite crystals occur in hexagonal flakes and resemble, sometimes, iodine crystals. Their form is that of the carborundum, out of which they are produced. As wood after being charred still keeps its structure, so carbide of silcon keeps its form when transformed by heat into graphite. The silicon is simply eliminated, $SiC = C + Si$, and a skeleton of the original structure is preserved in carbon.

(2) *The Carborundum Crystals.*—The carborundum crystals occur as the chief products of the reaction between carbon and silicon. They are located between the graphite and a layer of what seems to be an amorphous form of carbide of silicon. The whole mass of the crystals forms a green shell which is easily crushed and separated into the individual crystals. Their color is greenish gray, greenish yellow, greenish blue, etc. Their size differs very much, and depends upon the quantity of material brought into action, on the operation itself, and on the time of the reaction. The crystals are often so small that their shape can only be recognized with the microscope; often so large that they have a diameter of several millimeters.

We must assume that the process takes place according to the equation, $SiO_2 + 3C = 2CO + CSi$; or,

$$(1)\quad 2SiO_2 + 4C = 4CO + 2Si$$

$$(2)\quad 2Si + 2C = 2SiC$$

These crude crystals consist essentially of carbide of silicon, besides some impurities—oxide of aluminum, iron, etc. In order to clean the crystals, to free them from the impurities attached to them, a sample of the crude material as it came from the furnace was crushed, pulverized, floated, and finally prepared in the form of a very fine powder. This was placed in a combustion tube, heated to a red heat, and treated with a current of oxygen. Being thus burnt in oxygen, it was boiled alternately with caustic soda, water, hydrochloric acid, and afterwards it was given a prolonged treatment with hydrofluoric acid to which a little sulphuric acid had been added. This action being over, all silicon tetrafluoride, hydrofluoric and sulphuric acids were driven off, and the powder washed and dried.

By this treatment carbide of silicon was obtained in an almost pure state.

The pure silicon carbide has a specific gravity of 3.22. It is insoluble in all of the ordinary solvents, as hydrochloric, nitric, sulphuric, and hydrofluoric acids, but it is decomposed by caustic and carbonated alkalies.

Heated to a white heat in a platinum crucible, the powder shows a yellow green golden color of remarkable beauty, some of the powder being at the same time burnt up. The loss per hour is about one-half per cent. This indicates that silicon carbide is very little combustible in oxygen:

$$CSi + 4O = CO_2 + SiO_2.$$

It is easy to decompose it by heating with substances like chromate of lead or oxide of iron, and with a mixture of chromate of lead and bichromate of potash it even explodes.

The very fine powder, when floated in water, does not entirely settle, even after several months; this property of suspension is, however, immediately ended by adding acids or salts.

(3) *The Amorphous Carbide of Silicon.*—This substance forms a layer of greenish gray, bluish green, and white particles of the size of the original sand from which they evidently originate. The particles have no definite form, are very soft and therefore easily crushed to a fine powder, and this was found to contain the same constituents as the carborundum. It was evident that it was an amorphous form of carbide of silicon and therefore a somewhat similar process of purification was employed.

The cleaned powder consists essentially of silicon carbide in an amorphous form. Its specific gravity is 3.22, the same as the crystallized variety. It seems, however, to be more easily combustible.

(4) *The Unaltered Mass.*—The next material we come to is a mass of the original mixture, which has been very little, or not at all, changed by the operation of the furnace.

(5) *The Gases.*—The gases evolved at the beginning, during, and near the ending of the reaction have been analyzed. They consisted of a mixture of hydrocarbons derived from fresh coke and oxide of carbon with a small admixture of air.

Samples are not shown because you probably have already seen the display of this splendid material in the gallery of the mining building. This new material seems to me likely to cause a revolution in the abrasive market.

RAPID METHOD FOR THE DETERMINATION OF MANGANESE IN MANGANESE BRONZE.

BY JESSE JONES.

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THE following method is in use in this laboratory for the determination of manganese in manganese bronze. It is an adaptation of a well-known method in common use for the determination of manganese in iron and steel. A determination can be made in less than one hour, and as the amount of manganese in the ordinary run of work seldom exceeds 0.10 per cent., the method gives fairly satisfactory results.

The Method.—Dissolve five to ten grams of drillings in nitric acid of 1.20 sp. gr., using a large beaker to avoid frothing over. An excess of acid must be avoided as it interferes with the precipitation of the copper by hydrogen sulphide. When solution is complete, transfer to a 500 cc. cylinder without filtering out the precipitated stannic oxide. Make up to 300 cc. and pass a rapid current of hydrogen sulphide from a Kipp's apparatus until the supernatant liquid is colorless. Decant off through a dry filter, 180 cc. corresponding to three or six grams of sample, and boil down rapidly to about ten cc. Transfer to a small beaker and add twenty-five cc. of strong nitric acid. Boil down one-half, make up with strong nitric acid, boil, and add one spoon full of potassium chlorate. Boil ten minutes and add another spoon full of potassium chlorate. Boil till free from chlorine, cool in water, and filter on asbestos, using filter pump. Wash with strong nitric acid through which a stream of air has been passed. When free from iron wash with cold water until no acid