

## THE SPECTRA OF BORON.

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The element Boron occupies an interesting place in the periodic table. With an atomic number of 5, it is the simplest atom with 3 valence electrons. The spectrum of neutral boron, then should throw considerable light on the spectra of other atoms with 3 valence electrons, e. g. Al, Sc, C<sup>+</sup>, Si<sup>+</sup>, N<sup>++</sup>, P<sup>++</sup>, O<sup>+++</sup>, S<sup>+++</sup>, F<sup>++++</sup>, etc. The spectrum of ionized Boron (B II) should be similar in many respects to that of Be I and Al II, both of which have been investigated in this laboratory. In the spark, we should also expect the spectrum of B III (B<sup>++</sup>) which should resemble Li I, Be II and Al III.

In spite of its importance, very little work has been done on the spectra of boron. First of all, pure boron is extremely hard to prepare. Boron is fairly easy to prepare by Moissan's method, but it still contains more than 5% of oxygen, as well as other impurities. This material is a brown powder, very light, and its spectrum hard to excite. It is an extremely poor conductor, and hard to fuse. For this reason its spark spectrum has only recently been investigated. In this present investigation we are attempting to prepare some pure boron, and to measure its spectra in the arc, spark and vacuum spark.

First of all, a quantity of boron was prepared by Moissan's method. Boric acid (H<sub>2</sub>BO<sub>3</sub>) was fused, and fused B<sub>2</sub>O<sub>3</sub> resulted. This was crushed and ground to a powder, mixed with one-third of its weight of magnesium powder, and fused. At about 900°C. a reaction took place whereby the B<sub>2</sub>O<sub>3</sub> was reduced, and a mixture of free boron and magnesium borates, and borides was formed. In all about 30 Kg. of boric was used, and 20 Kg. of crude fusion was obtained. All this work was done in the Ceramics laboratory of the University of Illinois, for which grateful acknowledgment is made.

The crude fusion was next digested with hydrochloric acid. This decomposed the borides and borates, giving boric acid, and leaving the boron. The material was filtered through an alundum filter plate in a 6 in. Buchner funnel. Some difficulty was found in getting an acid proof cement to fix the plate into the funnel. Melted sulphur was finally poured in and with this cement strong boiling hydrochloric acid solutions were

successfully filtered. The material was washed a number of times with acid, finally with water, and then dried in an oven. The yield was 1300 g. of good boron. This is perhaps the largest quantity ever prepared of this element.

This boron is being used as a starting point for the preparation of pure boron. The boron is put into a combustion tube, dried at a red heat in a current of hydrogen, and then chlorine is passed over it. The chlorine burns the boron to  $BCl_3$  which is condensed at a low temperature. The chloride is then carefully distilled in a three column atomic weight still, to get pure  $BCl_3$ . This is mixed with pure hydrogen and passed over a hot tungsten wire, where boron is formed on the wire. Boron prepared by this method consists of beautiful, hard, gray crystals.

In the meantime, some spectrographic work was done using the powdered boron prepared by Moissan's method. Arc photographs were taken with a copper arc loaded with powdered boron. The characteristic boron arc only appeared after the arc had been running long enough to secure high temperature, when the copper and boron appeared to alloy forming a substance which when cool was a rich plum color, very hard and brittle. With 5 or 6 amperes and 210 volts D. C. a very brilliant and very white light, requiring but a fraction of the exposure time for the copper arc, was obtained. A piece of the same copper rod was used for a comparison arc.

Electrodes for the spark spectrum were made by a similar process, using small hollow copper cylinders filled with boron powder. As the copper walls melted down the boron reaching a white heat sintered leaving a cone shaped tip capable of withstanding the shock of the high tension spark.

The photographs were taken with a Hilger E1 quartz spectrograph, using Cramer's Contrast plates. In the region 2000-2500Å the plates were oiled with Nujol. The spark was a condensed discharge from a 4.5 K.W. 63000 volt Thoraisen transformer. The electrodes were placed 0.5 cm. apart with a 10 cm. gap in series. Both the arc and spark were photographed from 2050Å to 5200Å, and from 4500 to 6680Å; glass parts and Ilford Panchromatic plates being used in the latter range.

Both line and band spectra were obtained and lines due to suspected impurities such as magnesium were observed.

Grateful acknowledgments are due Prof. R. F. Paton, under whose direction this work was done.