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LA - 151

[redacted] C.3

October 4, 1944

This document contains 5 pages

PLASTIC BONDING OF BORON POWDER

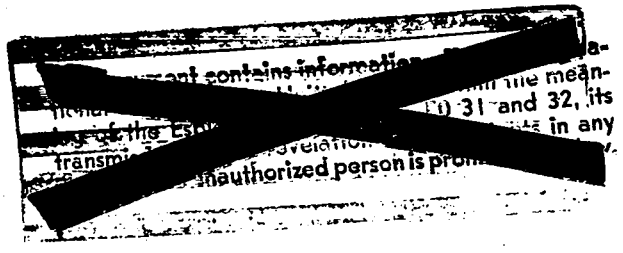
WORK DONE BY:

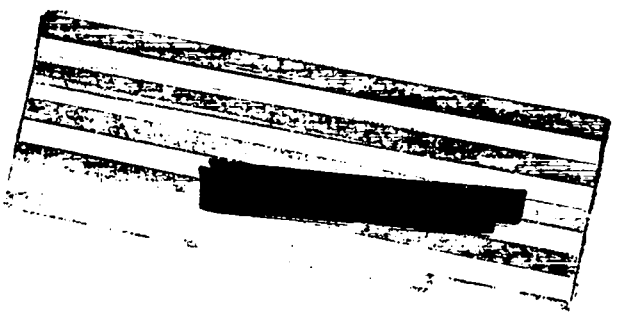
L. Hays

REPORT WRITTEN BY:

L. Hays

J. E. Burke





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ABSTRACT

This report describes a method for bonding boron powder by wet-tamping it with methyl methacrylate monomer and polymerizing the monomer to produce a finished, handleable piece which has a boron density of at least 1.6. The method has the advantage that almost any shape can be made without constructing expensive dies or using a press. It should be possible to bond other materials in the same fashion and obtain comparable percentages of the density of the pure solid.

PLASTIC BONDING OF BORON POWDER

There are a number of uses for boron in the form of high-density, handleable shapes. F. G. Stroke (LA - 127) has investigated a number of methods for producing these. A summary of his results (for 30 percent porosity) is given in Table I.

TABLE I

Method	Boron gms/cc	Bonding Procedure
Sintered B_4C	1.64	Hot press in graphite die at 2200° C
B + B_2O_3	1.75	Hot press in graphite die at 800° to 1000° C
B + PbB_2O_4 • B_2O_3	1.77	Hot press in graphite die at 800° to 1000° C
B + Lucite	1.58	Hot press in steel die at 120° C
B + Polystyrene	1.58	Hot press in steel die at 150° C

These methods produce pieces having good boron density and good compression strength, but they require rather elaborate equipment and are time consuming.

The object of this work was to produce high-density plastic-bonded compacts of boron without the expense and difficulties of the above methods. It is quite feasible to prepare satisfactory compacts having a boron density of 1.6 grams per cc by tamping boron powder wet with a solution of plastic monomer, and then polymerizing the plastic. The strength of these compacts is certainly not as high as the strength of the compacts produced by Stroke's procedures, but they will withstand considerable rough handling.

Best results were obtained with a final composition of ten-weight-percent methyl methacrylate. It is difficult to control the composition closely

because the monomer evaporates during mixing and tamping. The proper composition for good results is best obtained by adding monomer to the boron until only a small amount oozes from the material on tamping. An initial composition of eighteen-weight-percent monomer mixed with 60F boron gave good results in the present work. Benzoyl peroxide, to the extent of 0.25 percent of the weight of the monomer should be added to accelerate polymerization; more does no harm.

Dies made of several parts and assembled with bolts are desirable, since it is necessary to open the die to remove the finished piece. The die may be constructed of any material which is insoluble in methyl methacrylate monomer; the work described in this report was done in cylindrical dies made from one-and-two-inch brass tubing. The tubing was slit longitudinally and then lightly silver-soldered on the ends to maintain its shape and yet permit the removal of the compact after polymerization by breaking the welds. The tubing was soft-soldered to a brass sheet to give a smooth surface to tamp against.

The material is best tamped in layers $\frac{1}{4}$ to $\frac{1}{2}$ inch thick. For cylinders it was found desirable to use one tamping rod of small cross-sectional area for preliminary tamping, and a rod of cross-sectional area but little less than that of the cylinder for final tamping.

Polymerization requires at least forty-eight hours. The temperature should be maintained at about 50° c. Polymerization should be conducted in a closed container if possible, for it occurs much more rapidly this way and evaporation of the monomer from the surfaces of the material is avoided.

A boron density of 1.6 gm/cc was obtained. This is as good as can be obtained by pressing plastic-bonded compacts. In the present work the boron

density was determined by accurately weighing the boron and carefully loading the die to avoid any loss of material, and then determining the final volume of the compact after polymerization.

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