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INVESTIGATING THE EFFECT OF MOLASSES CONCENTRATIONS ON THE CHARACTERIZATION OF EVAPORATION BOAT WASTE FOR CRUCIBLE MATERIALS CANDIDATE

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ABSTRACT

The crucible is a container wherein metallic materials are melted in order to generate new objects or alloys. Crucibles are typically formed of ceramic, graphite, silicon-carbide, and steel. Until now, there has been no study on the use of evaporation boat waste and molasses for the manufacture of crucibles. This study shows that molasses was used for binding the crucibles production formed from evaporation boats waste. The goal of this research was to ascertain how using molasses affected the properties of the crucible produced. Evaporation boat waste is made into powder (mesh 80) using a hammer mill. Molasses, evaporation boat waste powder and water with a certain concentration are mixed homogeneously using a mixer. The mixed material is put into a mold that has been adjusted to ASTM C1161-18, and then the compaction process is performed (20 MPa) to produce a green body. The resulting green body underwent a 16-hour drying time in an oven set at 100°C. Afterward, it was sintered for 240 minutes at 1150°C. The specimens in this study were characterized using XRD, SEM, density, hardness and 3-point bending tests. The test results show that molasses as a binder in the manufacture of crucible specimens does not result in the formation of a new crystalline phase. 5% molasses produced the best specimens. In specimens with 5% molasses, the density, hardness, flexural strength, and weight percentage (%) crystal phase of BN and TiB_2 were 2.25 g/cm^3, 61.6 HRA, 49.96 MPa, 67.5%, and 32.5%.

Keywords: crucible, evaporation boat waste, molasses

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INTRODUCTIONS

Evaporation boats are material alloys used to produce thin aluminum films in decorative, plastic, glass, or food packaging applications in a high vacuum chamber [1]. The plastic metallization process is a process carried out by heating aluminum using evaporation boats to the melting point in a vacuum chamber so the atoms and molecules evaporate and stick to the surface of the plastic which moves at high speed and is then cooled rapidly so it crystallizes and forms a thin layer over the entire plastic layer [2]. This technology is widely used by the manufacturing industry that produces food packaging products such as PT 3M Indonesia. However, in its operation, industries engaged in this field always produce waste called evaporation boats waste (Figure 1). It is because of the lifespan of material evaporation boats which is only 15 hours [2]. After 15 hours, it is necessary to replace evaporation boats to maintain the effectiveness of the plastic metallization process. This is what causes the large volume of evaporation boat waste generated in the plastic metallization industry. 3M™ Evaporation Boat Dimet is made of Boron Nitride (BN) and Titanium Diboride (TiB_2) [3]. Both boron nitride (BN) and titanium diboride (TiB_2) exhibit exceptional levels of wear resistance, hardness, high-temperature stability, and melting point. These allow for the widespread use of BN and TiB_2 in industrial processes such as metal evaporation plating, wear-resistant coatings, and aerospace applications [4]–[6]. TiB_2-BN composite ceramics have good electrical conductivity, high wear resistance, and great machinability [5], [7]. Additionally, the mixture of TiB_2 and BN offers superior electrical conductivity and lubricity for molten metals. In the aluminum casting sector, TiB_2-BN composite ceramics are therefore frequently utilized [5].

Figure-1. Evaporation boats waste.

The large volume of evaporation boat waste shows the abundant availability of Boron Nitride and