AA24 - High Purity Aluminas for Advanced Ceramics Applications

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Abstract

Alumina is one of the most common raw materials and largely used for Refractory as well as Ceramic products. In recent days, the demand for high quality raw materials for advanced ceramics is growing due to smart materials like solar panels, LED lighting, electronics, batteries, LCD and specialty glasses. Hindalco is committed to supply materials to make the world greener, stronger and smarter. Hindalco Brasil is having state of art facilities for producing high purity alumina for advanced ceramic applications.

Hindalco-Brasil has developed a wide range of premium alumina grades, such as 3N (99.9% purity), with different crystal size in ground as well as unground form for various applications. The reactive alumina with ultra-low soda content has been developed for Li-ion battery applications. Also, Hindalco-Brasil is supplying ultra-low soda bimodal alumina products with very low water absorption for excellent particle packing and to achieve very good green densities.

This paper elaborates about the variety of high purity alumina grades for various advanced ceramics applications.

Keywords: Calcined alumina, reactive alumina, crystal size, ceramics, ultra low soda.

1. Introduction

High Purity Alumina (HPA) is chemically inert in most environments, has a very high melting point, has a very low electrical conductivity, is a good conductor of heat, and is very abrasive. HPA adds significant performance and safety characteristics when used in lithium battery separators. When HPA is grown into synthetic sapphire crystal it is used in LED light / semiconductor substrates, phosphors/diodes, lasers and optical lenses.

High purity alumina is used in a range of hi-tech applications. The global market is segmented based on application such as LED, Li-ion batteries, honeycomb ceramics, and others. Lithium-ion batteries and industrial applications are anticipated to witness robust growth. The segment growth is attributed to increasing demand for lithium-ion batteries in electric vehicles. There is also a growing demand in LED lighting applications in the global market. Sapphire substrate made of high purity alumina is used in LED lights and there is no suitable alternative available in the market. Semiconductors, which is another prominent application for high purity alumina is estimated to account for around 20 % market value share in the overall market. The segment is anticipated to witness steady growth owing to increasing demand from SOS (sapphire on silicon) semiconductors.

2. About Hindalco Brasil

Hindalco Do Brasil (HDB) is a wholly owned subsidiary of Hindalco Industries Limited with alumina refinery and bauxite mining assets in Brazil. This alumina refinery has the capacity of ~ 145 thousand metric tons (on an alumina basis) ideally suited for specialty products that cater to wide industrial applications. This is one of the largest specialty alumina producers in Brazil with ~56 % (in FY20) domestic market share. HDB holds good quality bauxite reserves which are among the largest in Minas Gerais. This plant has excellent multi-modal connectivity to key ports in Brazil.

This plant has state of art technologies to produce high purity alumina (99.9 %) and low soda, bimodal reactive alumina. Skilled on ground technical teams with new product development capability is available to scale up operations and unlock value.

3. HPA Alumina (99.9% Purity) for Li-ion Batteries

Lithium-ion batteries (LIB) are used in a wide range of electronic devices for storage of energy due to high cell voltage, good energy density and long shelf life [1]. Polymer separators in LIB are coated with ceramic materials especially with HPA prone to thermal runaway. This helps to improve the safety and performance characteristics. The low alkali like soda level is very important to withstand high voltage and high energy density.

Also, the particle size of alumina is the key factor in determining slurry consistency and the quality of the coated separator [2]. The particle size distribution of HPA is critical in determining the performance of Lithium-ion battery cells with the separator. HPA coated separators could be used in an extra-wide range of temperatures, from low temperature (e.g., -20 ^{o}C) to high temperature close to 300 ^{o}C in future [3].

HDB has developed high purity alumina (99.9 %) mainly to use for Li-ion battery separators. The critical properties of this type of alumina are chemical purity and particle size. This is a super ground alumina with controlled d_{90} (top cut) which is suitable for coating applications. The calcination with utmost care is important to produce a feedstock with low impurity content. After calcination, the necessary process check was followed for milling in ball mill to avoid further addition of impurities. This market is forecast to grow strongly.

The high melting point of HPA provides greater thermal stability to the battery, improving safety. HPA is a good electrical insulator while allowing ions to flow freely. HPA significantly improves impedance (Macmullan number <3) allowing for high power capability and low temperature performance. HPA filled separators improve battery life cycle and lower self-discharge [4]. The analysis of HPA which was developed by HDB is given in Table 1.

The crystal size decides the quality of coating on separators. The crystal size can be measured by SEM. An SEM image of this high purity alumina is given in Figure 1. The particle size distribution of OP1004 alumina is given in Figure 2.

12. References

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