High Purity Alumina – Another way aluminium is part of the clean energy revolution

By **Marghanita Johnson***

Aluminium oxide (Al_2O_3), better known as alumina, has been produced in Australia for more than fifty years and is largely supplied to the global aluminium smelting industry as metallurgical grade alumina, usually at purities of more than 99%. Australia is the world's second largest producer and world's largest exporter of metallurgical grade alumina, producing more than 21 Mt per annum. Alumina refineries can also produce alumina for a range of non-metallurgical uses, including water treatment; production of aluminium fluoride; ceramics, refractories and abrasives.

HPA – How many Ns

However, there has been an emergence in demand for very high purity alumina's. Known as just that – High Purity Alumina (HPA) – the products range in purity of more than 99.99% (4N) through to purities of more than 99.9999% (6N). While the difference between 99% (known as 2N) and 4N may be subtle, it has a profound impact on everyday items in our lives. HPA was first developed in the 1940's with the primary application being directed to the war effort as a substitute route for making aluminium metal. The production cost was higher than standard aluminium production, so post war HPA production was largely neglected. Until about five years ago, HPA had a very small market demand of only 15,000-16,000 tonnes per annum. More recently demand has grown due to the need for its quality, purity and versatility in high-tech applications. Today the market stands at more than 30,000 tonnes per annum and has been widely forecast to have a compound annual growth rate (CAGR) of about 20%.

This increased demand is driven by an increased global demand for a new world of technologies. HPA's properties such as high brightness, resistance to corrosion, good thermal conductivity, high melting point, chemical stability and high mechanical strength make it suitable for manufacturing various electronic and vehicle components, including for both electric vehicles and the aeronautical sector. It is used to make safer, more efficient and longer lasting lithium-ion batteries, synthetic sapphire for LED lighting and high technology optics. Use of HPA in battery technologies which would mean batteries have about a 30% higher retention capacity compared to conventional anode materials, with potential cost benefits and increased range for electric vehicles. There are many other niche applications for HPA in a ceramic form which include abrasives, substrates and electrical components.


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Like many manufacturing processes, production of HPA is energy intensive with the higher order refining needed to increase purity generally requiring higher energy use. HPA has traditionally used aluminium as a feedstock, and then chemically converts it back to alumina. This has meant that historically, HPA has had a high carbon emission intensity.

However, as new processes are being designed there are opportunities to reframe this expectation and develop low carbon HPA products. This reflects a broader emerging trend in supply chain management, where companies and their customers increasingly expect that products and the raw materials that comprise them, are produced with a minimal carbon footprint. The applications for HPA in low carbon markets are growing, making HPA a critical mineral of the future.

Australia is developing novel processing technologies

Given the positive CAGR and Australia's long track record in the alumina industry, it is not surprising that there are now a range of novel Australian HPA projects in the pipeline. In 2021, the Australian Aluminium Council took the strategic decision to represent the HPA industry as well as traditional metallurgical alumina producers. This recognises the role of this new HPA product in meeting the clean energy challenge as well as the recognition of the number of projects which are interwoven with the existing industry. Indeed, it is the strong regional bauxite and alumina industry in Australia which is being leveraged to create these new manufacturing opportunities.

The HPA projects have also received strong support from both the Australian and state governments, recognising the important role of HPA as a critical mineral.

For example, the Council's first HPA member, Alpha HPA, has announced its intention to construct what would potentially be the world's largest high purity alumina plant in Gladstone, with targeted production of 10,000 tonnes per annum. Gladstone is well known as the location of Rio Tinto's Yarwun and Queensland Alumina Ltd refineries, as

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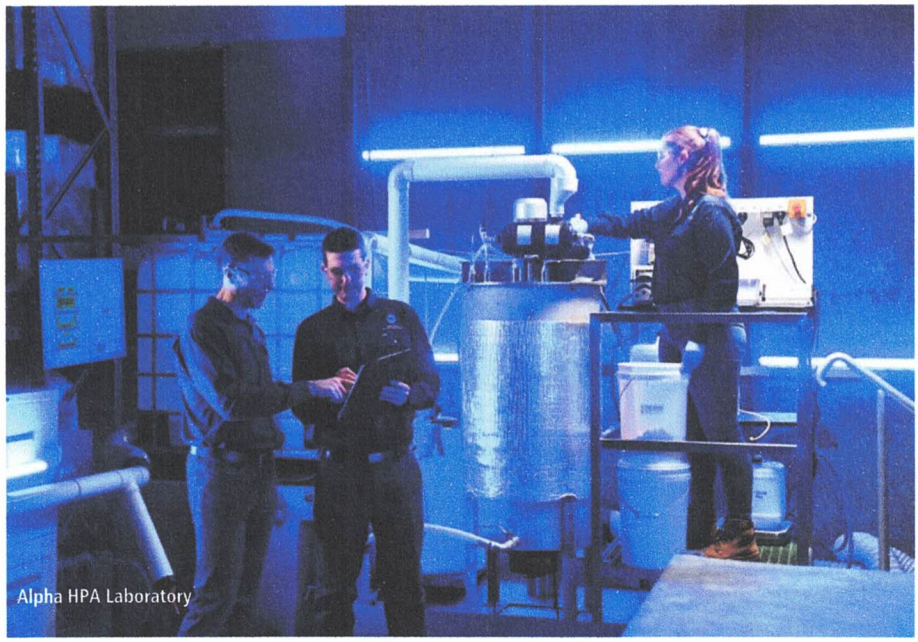
well as the Boyne aluminium smelter. The Alpha HPA process will use a precursor sourced from one of the alumina refineries in its "Smart SX" (solvent extraction) refining technology. The Alpha process also works with other neighbouring manufacturers so that by-products from its extraction process can be recycled, making the project an almost zero discharge facility. The solvent extraction technology, combined with renewable energy, aims to generate a range of HPA products with a carbon footprint lowered by as much as 60%. Alpha and Rio Tinto are both signatories to the Queensland Government's Statement of Co-operation for industries co-operating toward net zero emissions manufacturing.

Another well-known alumina refining location is south Western Australia. In 2021, integrated bauxite miner, alumina refiner and aluminium producer, Alcoa of Australia announced an HPA joint development project with FYI Resources Ltd. The project will have three main stages of development before potential construction, in 2024, of a full-scale 8,000 tonnes per annum HPA plant. This project is a natural complement to Alcoa's existing business, building on the company's expertise in alumina refining technology development and production capability.

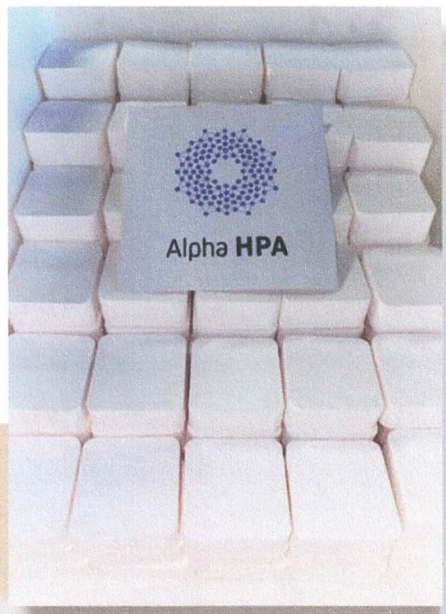
While Rio Tinto's Bell Bay Aluminium in northern Tasmania is still an operating aluminium smelter, between 1956 and 1972 the site also operated as an alumina refinery. As a result, it has a Tailings Storage Facility (TFS) housing red mud, commonly known as bauxite residue, a by-product of the Bayer process. Peloton Resources has proposed to construct an HPA pilot plant to valorise this bauxite residue to extract HPA and other critical minerals. Up to 15 tonnes per year of residue is proposed to be processed with the pilot plant to be sited immediately adjacent to the tailings storage facility, within the Bell Bay Advanced Manufacturing Zone.


Alpha HPA Laboratory

There are also a range of other projects, where HPA may be produced alongside other critical minerals. Developing new projects and novel processes today, means the Australian HPA industry is setting itself up for success as a location for low carbon and low waste production facilities of the future.

Conclusion

HPA is one of the many exciting new aluminium products, including aluminium alloys and salts, emerging to meet the needs of the global energy revolution, at the same time as satisfying increased consumer demand for the highest ESG standards of production. Australia is strategically positioned to support the development of these new opportunities, which can be made in Australia and distributed to the world as part of the ever-growing range of products we will need to meet technology challenges – today and into the future. ■



Alpha HPA Pucks


FYI Resources 99.999% (5N) HPA