

22 October 2014

## HIGH PURITY ALUMINA (HPA) MARKET UPDATE

### Highlights

- Global HPA market estimated at 19,040tpa in 2014 with increase to 48,230tpa anticipated by 2018
- Market growth forecast at a CAGR of approximately 28%
- Asia Pacific region HPA market share 70%
- Asia Pacific potential location for AMMG's HPA plant - best geographic position to service the large growing market
- AMMG will focus production towards 4N (99.99%) HPA product due to bulk of sales and demand
- As a new potential supplier, AMMG aims to meet the forecast HPA deficit as well as providing buyers with increased choice and flexibility

Australia Minerals and Mining Group Limited (ASX: AKA) (AMMG/the Company) is pleased to provide an update on the high purity alumina (HPA) market.

### HPA – NON-METALLURGICAL MARKET

Alumina or aluminum oxide, commonly known as  $\text{Al}_2\text{O}_3$ , is primarily used as a feedstock for the fabrication of metallic aluminum. Ninety percent of alumina known as “smelter grade alumina” (SGA) is used in aluminum metal production with the remaining 10 percent dedicated to the non-metallurgical market for specialty or chemical use. HPA, which characterises alumina with a minimum purity of 99.99%, is the high-end product of the non-metallurgical alumina market.

### HPA QUALITY

On the basis of purity, the global HPA market can be divided into the following products:

- 4N category - 99.99% pure, with an impurity level of only 0.01 percent (100ppm)
- 5N category - 99.999% pure, with an impurity level of only 0.001 percent (10ppm)
- 6N category - 99.9999% pure, with an impurity level of only 0.0001 percent (1ppm)



AMMG believes that the majority of global HPA sales and demand is at the 4N category and is therefore aiming to produce this product.

### HPA MARKET SIZE AND FORECAST

According to Technavio Research, the global HPA was estimated at 19,040tpa in 2014 and is expected to increase to 48,230tpa by 2018, growing at a CAGR of 28%.

The market is expected to witness significant growth during the forecast period because of rising demand from end-users and a positive outlook for the global economy. QY Research estimates the demand for HPA in 2014 to be 24,550tpa and growing to 36,000tpa in 2017. Their growth rate prediction is around 16% over this period.

### GEOGRAPHIC SEGMENTATION

The demand for HPA is dominated in the Asia Pacific (APEC) region with a share of 70% in 2013 which is where the electronic manufacturing centres are located (See Figure 1). The Americas accounted for a share of 14%, which is expected to increase to 18% during the forecast period. Europe, Middle East and Africa region accounts for 16% of the global HPA consumption.

The current majority of HPA producers are also based in the Asia Pacific region. China was the largest global supplier of HPA accounting for a share of 49% in 2013 followed by Japan with a market share of 21%. The Europe, Middle East, and Africa (EMEA) region accounted for a share of 16% with small regional vendors catering to the demand.

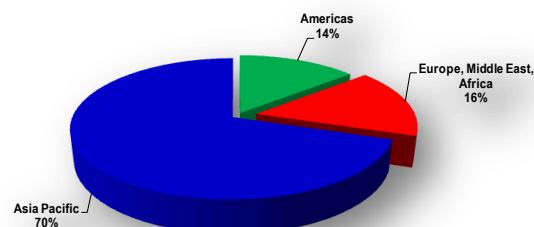


Figure 1 – Geographic Segmentation

AMMG believes most of the future demand will continue to be driven by the APEC region and the Company's strategy of having an "ore to HPA" production facility in this region is a distinct geographical advantage for supplying HPA.

### USES OF HPA

The global HPA market is driven by many factors, especially the growing market for artificial sapphire substrates for Light Emitting Diode (LED) products. The current high demand for HPA-based sapphire substrates for the LED market has greatly added to the growth in demand for sapphires, thus HPA. Products that use LEDs have high thermal stability, chemical resistance and mechanical strength. Another major driver in the market is the increased use of HPA in applications such as semiconductors (electronic devices), phosphor (plasma TV's), lithium-ion batteries (hybrid cars) and soft-focus translucent cosmetics.

The global HPA market is divided based on the following applications listed below:

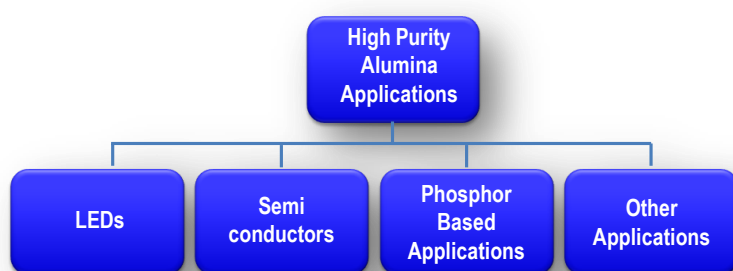


Figure 2 – HPA Market Applications

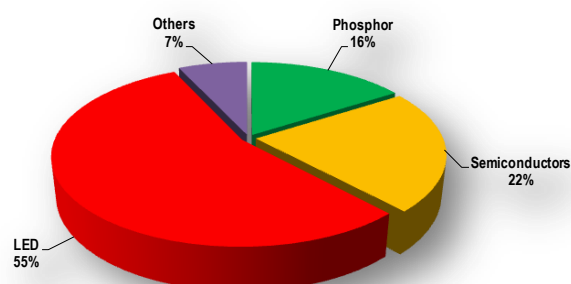


Figure 3 – HPA Applications Market Share

### **Light Emitting Diodes (LEDs)**

In the LED production process, artificial sapphires are used as a substrate onto which the emitting layer chemicals of the LED are deposited as a vapour. The majority of today's LEDs are produced on a sapphire substrate. Artificial sapphire is a crystal that is grown from HPA using single crystal technology: 99.99% pure HPA is melted at a temperature higher than 2300°C and then slowly cooled. Its hardness (number 9 on the Mohs scale of mineral hardness, which is harder than steel) and a high melting point of 2050°C make sapphire crystals very appropriate as a substrate. The shift from traditional incandescent light bulbs to energy-efficient and sustainable LED lighting has enhanced the demand for LEDs. LEDs are durable, sustainable, safer, and expected to replace traditional lighting products completely. The growing adoption of LED lighting by both developed and emerging countries from domestic to industrial applications (i.e. home lighting, televisions, hybrid cars and electric vehicles) is driving demand for LEDs and its main raw ingredient – HPA.



The LED segment held the largest share in the global HPA market accounting for 55% in 2013.

According to Technavio Research, the growing adoption of LED lighting is driving the market positively. Technavio states that the “falling cost of LED lamps and continued economic growth globally is increasing the penetration rate of LED lighting. The HPA market for LEDs was estimated 7,760tpa in 2013 and is expected to reach 31,810tpa by 2018, growing at a CAGR of 32%”.

### **Semiconductors**

HPA is widely used in semiconductor wafer processing equipment because it provides a high level of plasma corrosion resistance and high-bending strength. The semiconductor industries use HPA in electrolytic capacitor foils, plates for flat panel displays, microprocessors, electronic storage systems and bonding wires. Semiconductors are expected to experience steady growth during the forecast period because of increased global use of electrical and electronic devices and rapid economic growth in emerging countries. The semiconductor segment accounted for a share of 22% of the HPA market, which is driven by growth in data processing, consumer technology and communication sectors.



According to Technavio Research, the global HPA market for semiconductors was valued at 3,100tpa in 2013 and expected to reach 4,210tpa by 2018, growing at a CAGR of 6.3%.

The growing demand for high-performance data storage systems, consumer electronics and advanced industrial applications is increasing the adoption of semiconductors. Today's 'smart' digital systems and electronic devices rely on data processing equipment (from semiconductors) to produce tablets, smartphones and computers. These devices operate at high speeds and temperatures and require heat and corrosion resistance material to function

## **Phosphor Applications**

Phosphor-based applications accounted for a 16% share of the global HPA market.

Plasma display panels such as plasma TVs and computer screens are made of phosphor coatings in plasma cells, which use HPA to control the characteristics of the phosphorous material. Demand for HPA from phosphor-based applications is expected to grow at a steady pace because of the rising demand for thin screens. Increased demand for LED TVs, which also contain phosphor, is expected to contribute to the rising adoption of HPA.



According to Technavio Research, the global HPA market for phosphor-based application was estimated 2,260tpa and expected to reach 3,060tpa by 2018, growing at a CAGR of 6.25%.

## **Industrial & Other Applications**

HPA has specific applications in the field of abrasives, ceramics, and separation membranes as well as in the industrial, chemical and medical sectors. The adoption of these applications is expected to grow, which is expected to boost the growth of the market. Other applications such as automotive sensors and additional powder applications accounted for a share of 7% of the HPA market in 2013.

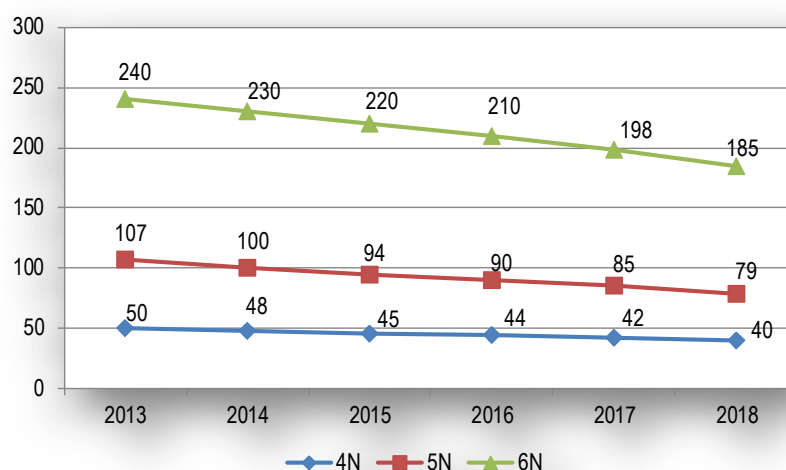
Nano-sized (ultrafine) HPA is a new material that is expected to open up new applications in the future. The applications relate to abrasives, ceramics and precision separation membranes. Using its chemical and heat resistance, HPA porous bodies are used to produce ultrafiltration applications, gas separation membranes and separator membranes in lithium batteries.

## **HPA PRICE FORECAST**

According to Technavio Research the global HPA market is expected to grow at a CAGR of 28%, but HPA prices are expected to stabilise as increases in supply from emerging small players and technological innovations will lower production costs, thereby lowering the price of HPA.

These prices are dependent on factors such as grain size and purity and the price of the substrate varies according to its purity level. Therefore, the 4N HPA category commands a lower cost, while the 5N and 6N category command a higher price.

**Figure 4 – HPA Price Forecast <sup>1</sup>**



During the Technavio Research forecast period, the price of the 4N category is expected to be between US\$50 and US\$40/kg. The price of the 5N category is expected to be between US\$107 and US\$79/kg. The price of the 6N category will be between US\$240 and US\$185/kg.

As mentioned previously, AMMG believes that the bulk of global HPA demand will likely be in the 4N category.

## **HPA MANUFACTURING TECHNOLOGY**

There are many industrial methods for producing HPA, including hydrolysis of aluminum alkoxide, thermal decomposition of ammoniumalum, thermal decomposition of ammonium aluminum carbonate hydroxide (AACH), underwater spark discharge with aluminum, vapor-phase oxidation and the like.

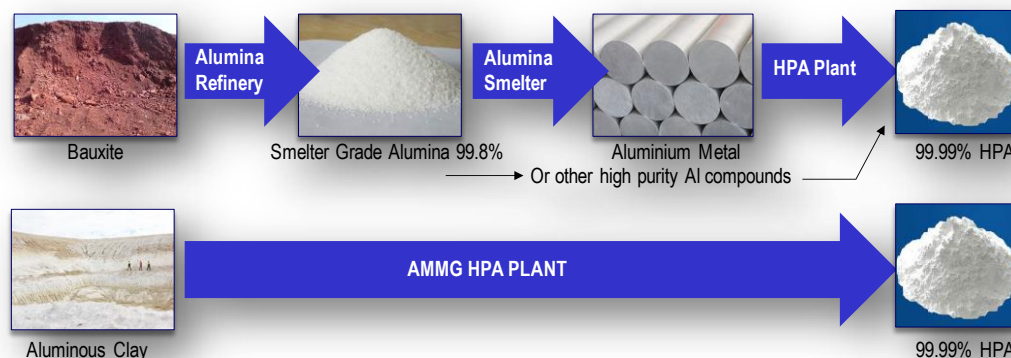
The most common process used by major producers is the hydrolysis of aluminum alkoxide. In this process, high purity aluminum alkoxide is synthesised from aluminum metal and alcohol, and hydrated alumina is produced by hydrolysis of alkoxide. HPA is then obtained by calcination.

This means that most current HPA producers are using an expensive and highly processed feedstock material such as aluminum metal to produce HPA quality product.

Technavio Research believes that the major challenge of the HPA industry is the rising cost of production as the manufacturing of HPA involves expensive feedstock, huge labor and energy costs and introduction of stringent government regulations.

AMMG is one of two companies in the world that publicly report producing 4N directly for an ore feedstock, such as aluminous clay. (see Figure 5).

**Figure 5 – Conventional HPA Process Vs AMMG HPA Process**



The main advantage of this strategy is that AMMG is utilising its low-cost, low-impurity aluminous clay feedstock, which has already been purified and processed by natural weathering processes over many millions of years.

As a result, the direct ore feed contains very low levels of impurities including iron, titanium, sodium, calcium, potassium and magnesium. The main impurity is insoluble silica, which can be easily filtered out during the processing, leaving the soluble alumina.

*"The global HPA market currently has a supply deficit, which is expected to be resolved because of the development of new technology that extracts HPA from aluminous clay resources. HPA producers are rigorously exploring the earth's crust for aluminous clay resources... An increase in aluminous clay resources will enable the global HPA market to overcome the supply deficit and enhance the production of HPA". Technavio Research*



AMMG believes that as a new producer of HPA with lower feedstock costs, the Company will contribute to the forecast HPA deficit as well as providing buyers with increased choice and flexibility.

#### References

- 1 Technavio Global High Purity Alumina Market 2014-2018.
- 2 2014 Deep Research Report on Global and China High Purity Alumina Industry - Beijing Hengzhou Bozhi International Information Consulting Co.,Ltd(QYResearch)
- 3 Jamie Fox, Lighting and LEDs, IMS Research, Opportunities for Sapphire

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#### **About AMMG (ASX: AKA)**

AMMG is aiming to become the world's leading supplier of 99.99% (4N) high purity alumina (HPA) (Al<sub>2</sub>O<sub>3</sub>) which is the major source material for scratch-resistant artificial sapphire glass, used in the next generation of smartphones and portable tablet devices. HPA is also used in the production of LED's, abrasives, ceramics and a growing range of high-performance electronic applications. The global HPA market is approximately 20,000tpa and is expected to double over the coming decade.



Current HPA producers use an expensive and highly processed feedstock material such as aluminum metal to produce HPA quality product. AMMG is one of only two companies in the world that report the ability to produce 4N HPA directly from an ore feedstock, such as aluminous clay. AMMG employs a well-established processing technology to extract HPA from a low-impurity aluminous clay feedstock sourced from the Company's 100%-owned Meckering project in Western Australia.

AMMG has produced test quantities of 4N HPA product and is now advancing a Bankable Feasibility Study (BFS) to develop a full-scale 3,000tpa production facility. AMMG is a chemical processing group focused on creating a high-margin product to meet the growing global demand for the next generation of high-performance electronic applications.

#### **Forward-looking Statements**

This announcement contains forward-looking statements which are identified by words such as 'anticipates', 'forecasts', 'may', 'will', 'could', 'believes', 'estimates', 'targets', 'expects', 'plan' or 'intends' and other similar words that involve risks and uncertainties. Indications of, and guidelines or outlook on, future earnings, distributions or financial position or performance and targets, estimates and assumptions in respect of production, prices, operating costs, results, capital expenditures, reserves and resources are also forward looking statements. These statements are based on an assessment of present economic and operating conditions, and on a number of assumptions and estimates regarding future events and actions that, while considered reasonable as at the date of this announcement and are expected to take place, are inherently subject to significant technical, business, economic, competitive, political and social uncertainties and contingencies. Such forward-looking statements are not guarantees of future performance and involve known and unknown risks, uncertainties, assumptions and other important factors, many of which are beyond the control of our Company, the Directors and management. We cannot and do not give any assurance that the results, performance or achievements expressed or implied by the forward-looking statements contained in this announcement will actually occur and readers are cautioned not to place undue reliance on these forward-looking statements. These forward looking statements are subject to various risk factors that could cause actual events or results to differ materially from the events or results estimated, expressed or anticipated in these statements.