TRENDS IN ALUMINIUM PROCESSING

CURRENT TRENDS AND TECHNOLOGY SOLUTIONS FOR THE GLOBAL ALUMINIUM PROCESSING SECTOR

Morgan Advanced Materials

Introduction

AS THE SECOND LARGEST METALS MARKET IN THE WORLD, THE ALUMINIUM SECTOR CURRENTLY HAS A TOTAL MARKET VALUE OF AROUND £45 BILLION.

Demand for aluminium continues to grow in a number of sectors, not least the automotive sector, where ever stricter regulation on emissions is behind a continued drive to reduce weight.

Meanwhile, the rising prices of potential alternatives such as zinc and copper continue to make aluminium an attractive option for specifiers across a broad spectrum of sectors. Aluminium prices remain low currently due to oversupply and stockpiling, although modest output cuts have seen prices start to rise slightly.

Global demand estimates are for roughly 40 million tons of aluminium production by 2025 – meaning 230 million additional tons of bauxite must be extracted and processed. Analysts predict that the increased demand will mainly be fuelled by emerging economies such as India and China.

Production in 2016 is expected to be 59 million tonnes with consumption slightly higher, making modest inroads into stockpiles. However, prices are likely to remain depressed, perhaps even as low as $1,400 though they may rise towards the end of the year.

Global aluminium production in the first seven months of 2015 averaged just over 158,000 tonnes per day (tpd) compared with 143,300 tpd during the same period in 2014, according to the International Aluminium Institute (IAI). However, Chinese production fell to 87,871 tpd from 91,867 tpd in June. A long-term drop in Chinese output would be the key creating the type of supply deficit which would have a real impact on the stock burden.

Demand is likely to remain robust as it is still one of the metals with the most rapidly growing demand profiles.

MARKET OVERVIEWS BY REGION

India

Currently accounting for 8% of global aluminium production, the use of aluminium in India is dominated by the country's automotive sector, with recycling also growing very rapidly

What the rapid growth in the automotive sector has created is an increased focus on quality, particularly in the area of castings, alongside a need to minimise costs by reducing total cost of ownership.

China

The largest single market in the world for aluminium, China produces 43% of the entire world's aluminium but is still a net importer, consuming 44% of all aluminium used globally despite not being a market-driven economy. The rapid growth in the Chinese economy led to considerable overcapacity and the construction of many new smelting facilities, some of which have been agglomerated. This has been accompanied by a drive by the Chinese government to do away with the less economical and higher-polluting facilities.

Its automotive market has grown rapidly but this growth has slowed somewhat in recent years. Prices have suffered to a degree, partly due to overcapacity and excess domestic stock levels, but recovery is under way, bringing some smelters back on-line.

An increasingly important area is the production of high-purity aluminium for use in the electronics industry. While growth in this area has slowed slightly, demand is strong for products and technologies able to contribute to optimised purity. Energy is also an increasingly important driver and demand is growing for consumable products able to contribute to reduced usage.

China's exports of unwrought aluminium and products have fallen, partly due to lower premiums and outright prices. If Chinese exports do not rise, the world outside China may find itself in a deficit, which will help reduce stockpiles. But if prices rally because of lower exports from China, its exports are likely to pick up again.

EMEA

EMEA probably represents the most stable of all of the current main aluminium markets. One of the main developments here is the growing co-location of facilities for primary and secondary processing, to reduce transport and storage costs while benefiting from economies of scale. Perhaps more than anywhere else, quality is the key driver, both in terms of purity of the casting in terms of its metal content and also in ensuring that unwanted gas is removed from the process. The drive for quality applies not just to the secondary aluminium sector but to primary processes too, where processors are exploring the benefits of achieving greater quality at first melt stage.

Americas

The desire to reduce energy usage is not quite so pronounced in the Americas as in other regions due to the more prevalent use of gas-powered heating with gas generated from fracking. The market is strengthening rapidly, not least in the secondary aluminium sector, where the desire for quality and longer-lasting consumables to optimise productivity is behind many of the innovations being brought to the market by the major players.

Summary of global market trends

As is the case across the majority of industry sectors, the goal is to reduce total cost of ownership of production consumables. And while the focus on end product quality has usually been the preserve of the secondary aluminium processors, primary aluminium processors are also increasingly seeking to gain competitive advantage through optimised production quality.

Suppliers of consumables are realising that their products must be approved by OEMs, generating increased co-operation with machinery manufacturers at the component design stage.

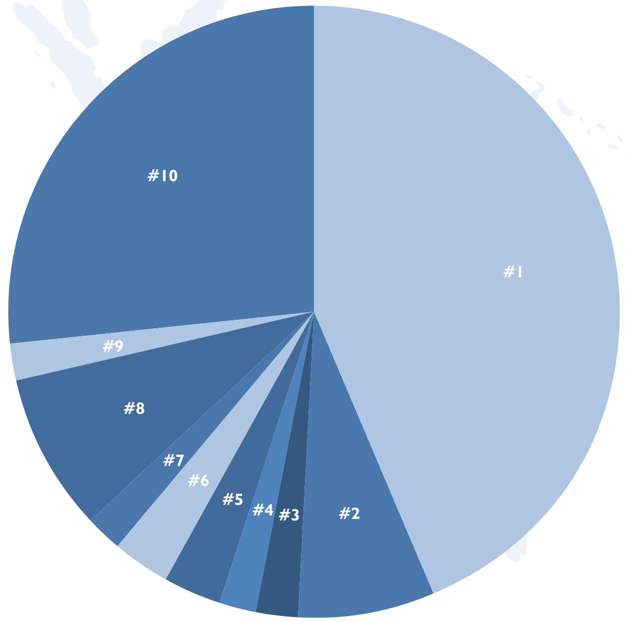
Price always remains a key driver, with falling prices having made some smelters uncompetitive. A further effect of the continued cost pressures is on the receptiveness to change within the sector. Traditionally very conservative and loyal to tried and tested techniques, products and processes, there is now a far greater openness to the use of alternatives in the areas of consumables, especially if these products can last longer – increasing maintenance intervals and lowering total cost of ownership – and reduce energy usage.

This last point is key in the light of rapidly rising energy costs and more stringent emissions regulation across almost the entire globe, with the possible exception of North America.

In the automotive sector, the goal of reducing vehicle weight remains at the heart of component development and design, with aluminium still representing an attractive option in terms of total cost of ownership compared with most other lightweight alternatives.

Ultimately current consumable innovation and supply is driven by the need to transfer energy better and to optimise finished product quality.

ALUMINIUM PRODUCTION CAPACITY BY COUNTRY



#1 China: 43%
#2 Russia: 7%
#3 Canada:2%
#4 USA: 3%
#5 Australia: 3%
#6 Brazil: 3%
#7 Norway: 2%
#8 India: 8%
#9 Dubai: 2%
#10 Others: 26%

Sources:
www.fastmarkets.com/base-metals/aluminium-price-analysis-forecast-q4-2015
www.aluminium-india.org/Worldscenario.php

OPTIMISING FURNACE INSULATION

Given the high energy usage of aluminium furnaces and the need to maintain consistent temperatures to optimise quality, any action which can be taken to reduce energy loss during the melting process is to be welcomed. Alongside this sits the requirement to meet increasingly stringent local and global safety regulation in the area of insulation materials. For many years, refractory ceramic fibreboard was the industry standard but concerns about its carcinogenic properties – meaning it is being outlawed completely in some regions – led Morgan to develop low biopersistent fibre-based alternatives. Originally launched to the market in the late 1990s, recent innovations have delivered higher melting points and improved insulation to meet ever more demanding process requirements. Well-suited to the aluminium industry because of their ability to withstand temperatures of up to 1,200°C (2192°F), these products are available in both blanket and board forms, making them suitable for applications in anode bake ovens, casthouses and potlines, and boast key properties such as low shrinkage – less than 1% at 700°C (1292°F) - and compression. A suitable solution can be developed based on individual application requirements such as: operating temperature; duration of exposure; compression; environment; installation method; single or multiple use; amount of handling; and airborne fibre exposure. Recent tests carried out at the most common operating temperatures for furnace back-up board – between 600°C (1112°F) and 800°C (1472°F) – revealed that in the key area of thermal conductivity, the latest low biopersistent fibre-based board outperformed Calcium Silicate by an average of 20% at 600°C (1112°F) and 15% at 800°C (1472°F).

Block products are also available for use as insulation layers in aluminium reduction cells where they offer low thermal conductivity – no higher than 0.16W/m.K at a mean temperature of 900°C (1652°F), high dimensional stability and hot compressive strength, and high cryolite resistance. Thickness shrinkage reaches a maximum of 2.8% at 1,100°C after 24 hours' soaking, with linear shrinkage under the same conditions no higher than 1.8%.

Our Superwool fibre is also available in paper, felt, modules and custom shapes. Morgan have specialised material for caster tips and we also supply furnace cones, seals, gaskets, thermal covers and flexible launders.

Dimensional Stability
Average results of thickness shrinkage (ASTM C-365) - 300°C to 1100°C

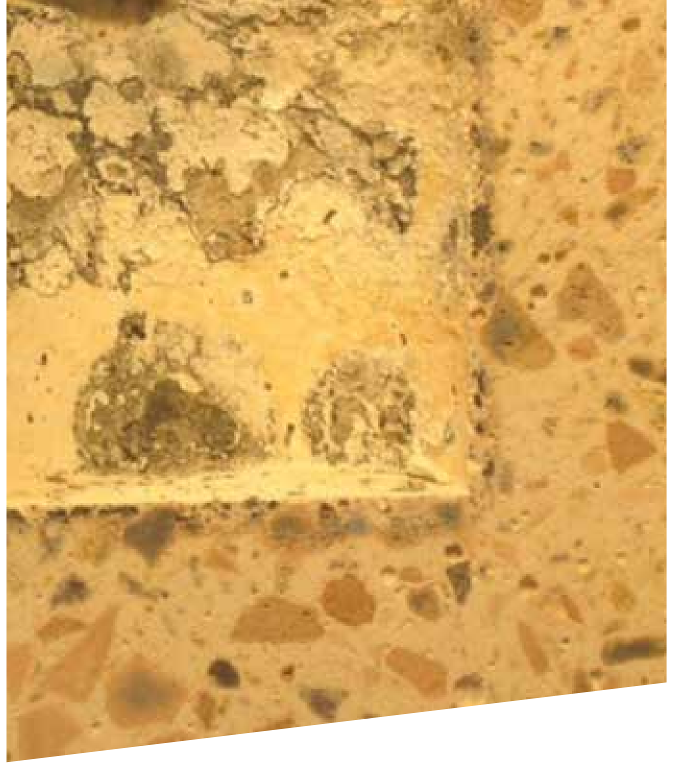
Product	Blok AL	Blok 800	Blok 1100
After 24 hours soaking at:	%	%	%
300°C	0.3	0.2	0.1
500°C	0.4	0.4	0.4
700°C	0.5	0.5	0.7
800°C	0.6	1.8	1.2
900°C	2.3	3.1	2.0
1000°C	2.7	4.2	2.1
1100°C	2.8		2.1

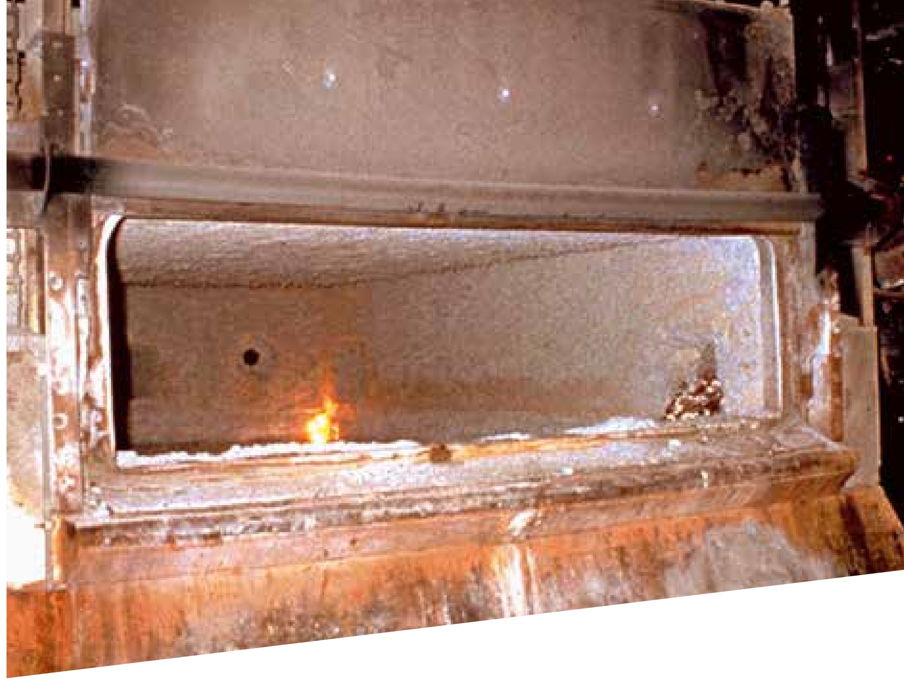
Thermal Conductivity

Product	Blok AL	Blok 800	Blok 1100
Thermal Conductivity (ASTM C-201) at a mean temperature of:			
200°C W/m.K	0.04	0.05	0.05
400°C W/m.K	0.06	0.06	0.07
600°C W/m.K	0.09	0.09	0.09
700°C W/m.K	0.11	0.10	0.10
800°C W/m.K	0.13	0.12	0.12
900°C W/m.K	0.16		0.14

Dimensional Stability
Average results of linear shrinkage (ASTM C-365) - 300°C to 1100°C

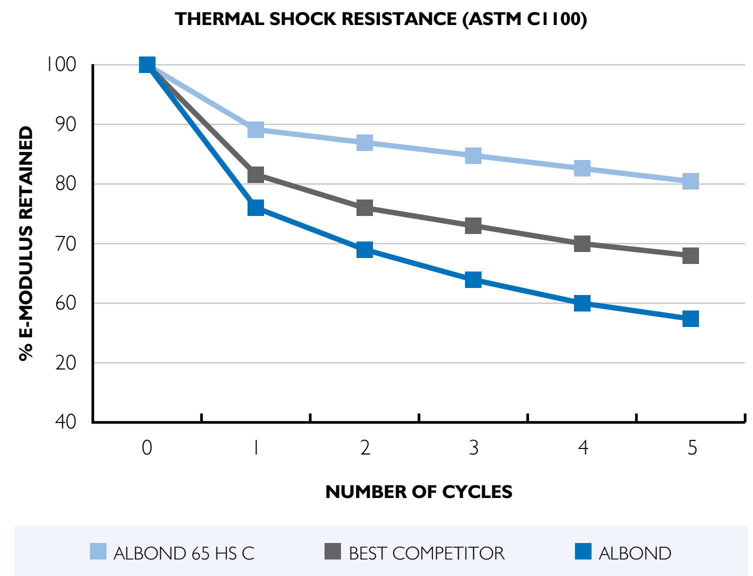
Product	Blok AL	Blok 800	Blok 1100
After 24 hours soaking at:	%	%	%
300°C	0.0	0.1	0.1
500°C	0.3	0.4	0.3
700°C	0.5	0.2	0.7
800°C	0.7	1.2	1.5
900°C	1.2	1.6	1.5
1000°C	1.4	1.7	1.8
1100°C	1.2		1.7

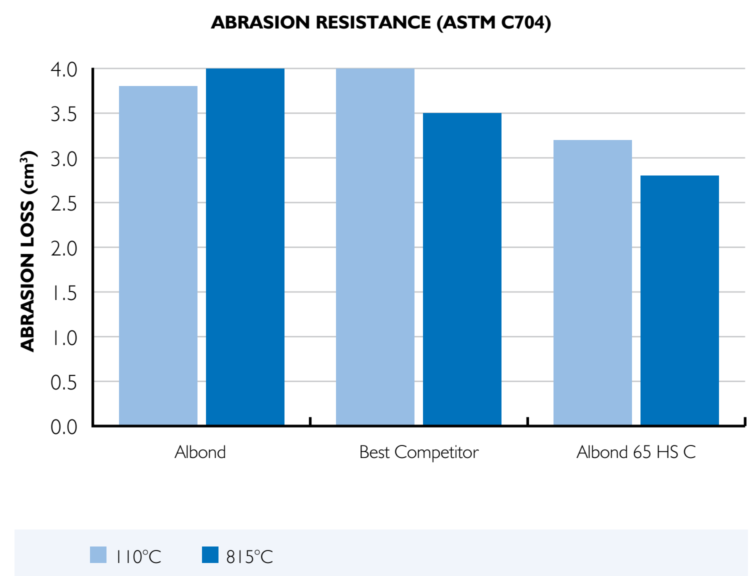




In the area of melt-hold furnace lining, continued investment in the optimisation of monolithic materials is delivering enhanced productivity and quality. These furnaces present a variety of challenges as each area of the furnace has varied requirements in terms of factors such as temperature, metal contact, flux contact and thermal shock, meaning suppliers must offer a variety of products with differing performance attributes. Products used on ramps, for example, must offer strong resistance to abrasion and thermal shock, as well as to aluminium and alkalis. The latest Morgan products boast abrasion loss as low as 2.8cm³ at 815°C (1499°F), significantly lower than that of competing products. Their pick-up of at 0.011% at 1,000°C (1832°F) over 100 hours is also more than 10 times lower than that of the nearest competing product.

It is a similar story on belly bands, where the highly aggressive metal-to-air interface makes resistance to salts and alloys crucial, as well as resistance to abrasion, aluminium and thermal shock. The lower walls, superstructure, door, jambs and lintels, back-up lining and burner blocks all have their own requirements too – and the issue of testing is complicated by the fact that many industry standard test conditions, based on lower temperatures and operating times, do not truly reflect how operators use their furnaces. The only real way to ensure the product is appropriate is to test it under real operating conditions in the application in question. Modern products are improving all the time and the right combination is not just easily achievable but integral to optimising performance and productivity while reducing energy usage.





SUPPORTING THE JOURNEY TOWARDS ENHANCED QUALITY

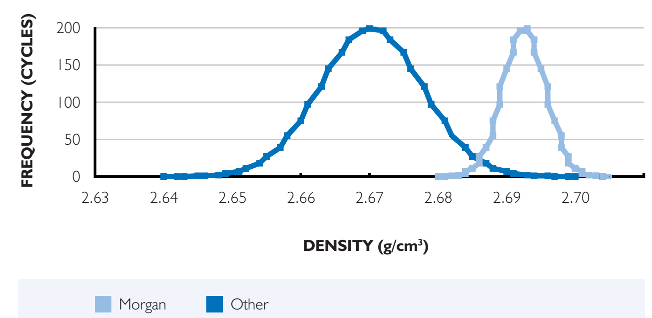
Quality in the secondary aluminium processing sector is inextricably linked to purity, especially in high-specification applications in sectors such as electronics. One of the key sources of impurity and physical imperfections – and therefore strength and performance issues - in cast aluminium components is the presence of gas, in particular dissolved hydrogen. This makes effective degassing technologies vital to production.

However, their role in removing gas from the process area must be matched with a long service life and an inertness to the presence of molten aluminium, as any reaction with the aluminium will itself cause impurities and potentially the loss of the cast product when it is machined.

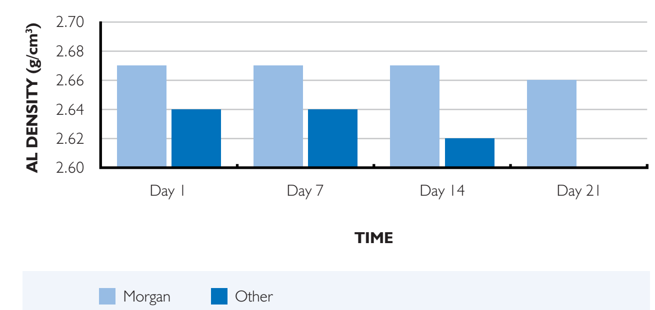
The latest degassing rotors introduced to the market by Morgan have been developed in silicon carbide, delivering a high-performance and cost-effective alternative to the graphite material traditionally used for this task. Graphite has previously been the most widely used material for degassing rotors but is subject to high replacement costs and frequent changeovers. Silicon carbide boasts superior wear resistance and anti-oxidation qualities when compared with graphite, meaning the new rotors can last up to five times as long as their graphite counterparts - one test revealed a usable life of more than 800 cycles in a heavy fluxing application, compared with an average of 300 for comparable graphite products - and are made from an isostatically pressed, single-piece design. The rotor head has been optimised to reduce bubble size and deliver optimum gas dispersal through an innovative six-vane design. In testing the new rotors have shown significantly lower oxidation levels compared with graphite products, whose degassing performance deteriorated as head geometry became distorted, while melt densities using the silicon carbide rotors were notably higher over time than with graphite products.

Degassing technology is also widely adopted in the primary aluminium sector, with the use of compact in-line degassing rotors to process molten aluminium via rotating nozzles directly in the casting trough between the furnace and the casting pit. These products are contributing to improvements in overall metal quality, productivity, and safety, as well as reducing operation and maintenance costs by up to 60%. In particular the need for high-cost heating elements and thermocouples is removed, while there is no need to remelt aluminium or to maintain molten aluminium between casts in the degassing chamber.

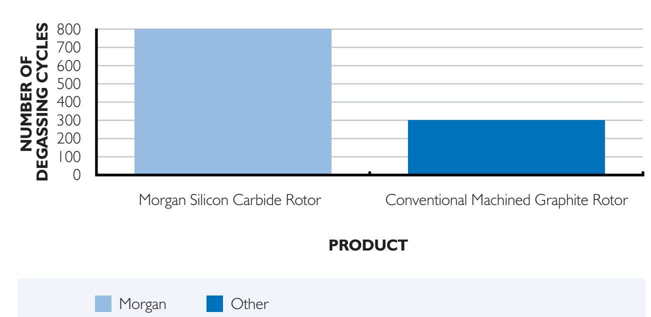
EFFECT OF DEGASSING ROTOR TYPE ON ALUMINIUM DENSITY



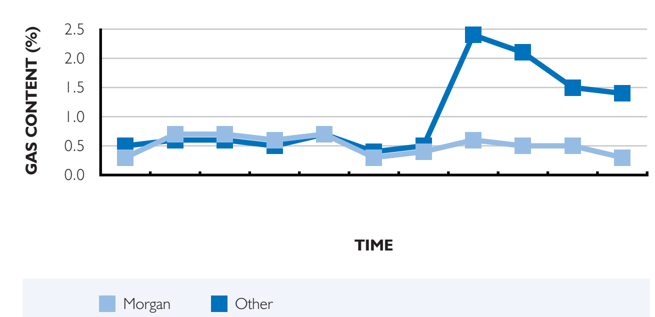
EFFECT OF DEGASSING ROTOR TYPE ON ALUMINIUM DENSITY OVER TIME



COMPARISON OF TYPICAL SERVICE LIFE OF DIFFERENT DEGASSING ROTOR TECHNOLOGIES



DEGASSING EFFICIENCY OVER TIME OF DIFFERENT DEGASSING ROTOR TECHNOLOGIES



COATING TECHNOLOGY

Another potential source of contamination in aluminium casting is the crucible in which the aluminium is melted. The high operating temperatures can cause fragments from crucibles, especially older products which have already seen lengthy service, to break off or melt into the molten aluminium, impacting significantly on purity and therefore on casting quality down the line – which may not be discovered until it is too late. The composition of the crucible itself can also be a cause of pollution. Where crucibles are 'run to failure' or changed at timed intervals rather than on the basis of actual wear, these effects can be significant and highly deleterious.

To combat these issues, a variety of specialist coatings have been developed by Morgan for all types of crucibles with different performance attributes depending on usage temperatures and desired performance. Coatings made from Al_2O_3, for example, play a key role in reducing dross adhesion and limiting metal contamination at temperatures of up to 1,600°C (2912°F). Other Al_2O_3 formulations deliver the same performance in very high purity applications. Where alloys using many fluxes are being processed, special glaze formulations can be applied to reduce flux attack on the crucible material.

These three coating types are all well-established but are now being joined by a new technology which pushes performance boundaries even further. Boron nitride coatings can contribute towards superior dross adhesion reduction and limit contamination in very high purity applications (e.g. 5N and 6N Al) and can withstand temperatures of up to 1,000°C (1832°F).

TYPE	TYPE OF CRUCIBLE	USEFULNESS	MAX METAL TEMP.
PD Coating			
Al_2O_3 Coating	All non impregnated crucibles	Reduce dross adhesion. Limit metal contamination	1600°C
Pro Coating			
Al_2O_3 Coating	All crucibles	Reduce dross adhesion. Limit metal contamination	1600°C
FL Coating			
High Performance Glaze	Clay-bonded crucibles - not impregnated	Reduce flux attack on crucible material	1000°C
STAR Coating - New product: Applications and advantages are still being explored.			
Ceramic Non-Wetting Coating	Clay-bonded crucibles (Iso-pressed and rib formed)	May provide superior dross adhesion reduction in aluminium. Limit metal contamination	1000°C

Summary

The global aluminium market is set to remain buoyant for the next few years at least due to its versatility, the variety of new applications, especially high-purity ones, and the high costs of many alternatives. Most regional markets are committed to growth and are seeking to work with consumable partners able to deliver solutions which can help them marry productivity and quality with reduced energy usage and emissions. The harnessing of innovative materials technology and design, and the expansion of existing technologies, will continue to create new opportunities for those suppliers able also to deliver agile and responsive service.

"The global aluminium market is set to remain buoyant for the next few years."

About Morgan Advanced Materials

Morgan Advanced Materials is a global engineering company offering world-leading competencies in materials science, specialist manufacturing and applications engineering.

We focus our resources on the delivery of products that help our customers to solve technically challenging problems, enabling them to address global trends such as energy demand, advances in healthcare and environmental sustainability.

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