

Zircon 101: where will new demand come from?

Zircon is important - and some would argue irreplaceable - in markets such as ceramics, which accounts for around 50% of demand. But, as *Cameron Perks, IM Correspondent*, discovers, there are new sources of interest within that same industry - and demand projections vary wildly.

Zircon (zirconium silicate - $ZrSiO_4$) is an important source of zirconia (zirconium oxide - ZrO_2) and zirconium (Zr).

Due to its density of 4.68, economic quantities of zircon are primarily contained within heavy mineral sands (HMS), a type of sedimentary deposit. Additional small quantities are also currently derived from baddeleyite mining in Kovdor, Russia. Zirconium and zirconia may be derived from various other minerals, with a notable example being eudialyte contained within Alkane Resources' Australian Dubbo Project.

Zircon finds uses in various applications such as ceramics, and in the foundry industry, mostly in the form of flour and sand for casting and refractory purposes. Zirconia as fused zirconia finds use in refractories, abrasives and ceramic

pigments, while zirconium chemicals finds use in gemstones, technical ceramics, cosmetics, coatings and more. Zircon is also used as zirconium metal, which finds use in nuclear applications, space and aeronautic industries, as well as in biomedicine.

According to the US Geological Survey (USGS), 2016 world production of zirconium mineral concentrates amounted to 1.46m tonnes. In that same year, Iluka Resources produced 347,000 tonnes of zircon.

Iluka Resources, the world's largest producer of zircon, estimates around 50% of its demand resides in ceramics, around 30% in refractory and foundry applications, and 20% of demand is from zirconia, zirconium chemicals and metal in 2017.

These demand figures are broadly in line with global estimates contained within The Zircon Industry Association's (ZIA) Technical Handbook

on Zirconium and Zirconium Compounds, published in 2015.

The ZIA states that the most important market for zircon and zirconia is the ceramics industry, where it is used in the production of "ceramic bodies, glazes, enamels, frits and pigments applied to traditional ceramics, which includes wall and floor ceramic tiles, porcelain tiles, sanitaryware, washbasins, tableware, special porcelains and industrial tiles, among others".

Zircon is commonly thought of as an opacifier in traditional ceramics, while zirconia has an important role in the production of ceramic pigments used in ceramic tiles, tableware and sanitary ware, among other products.

Historically, the growth of consumption in ceramics has been largely driven by tile demand. Growth in tile production can be linked to construction activity, with the highest rates of construction presently in Asia, especially China. The Chinese construction sector is the largest and one of the most rapidly growing in the world, despite several years of slow development.

As part of a business briefing session in 2015, Simon Hay, then general manager at Iluka, expanding on how the ceramics industry is changing in its consumption of zircon, stated that "over those past few years we've observed less zircon being used in the ceramic body and more zircon being used in frits, glazes and ceramic colour pigments, again associated mostly with digital printing changes."

The rise of tile digital printing has, according to Iluka, led to an increase in the popularity of glazed porcelain and glazed rustic tiles. This industry trend has resulted in "a year-on-year increase in zircon loadings", Hay said at the time.

Zircon may find further application in traditional ceramics as a partial replacement for zinc oxide in sanitaryware, according to a paper by Boudeghdegh et al. (2015) who also concluded that 14.5 wt% of zircon and 2.5 wt% of ZnO , shows better physical-mechanical properties and aesthetic whiteness when compared with the reference sample containing 7-9 wt% zircon.

Aside from traditional ceramics, zirconia can be turned into an advanced ceramic by either 'stabilising' it or by mixing it with other compounds such as alumina zirconia. The



Iluka Resource's Jacinth-Ambrosia deposit is capable of producing up to 300,000 tpa zircon, with production levels typically related to market demand conditions. Indeed, Iluka announced in February 2016 that mining and concentrating operations are to be suspended from 16 April "for a period of 18-24 months".

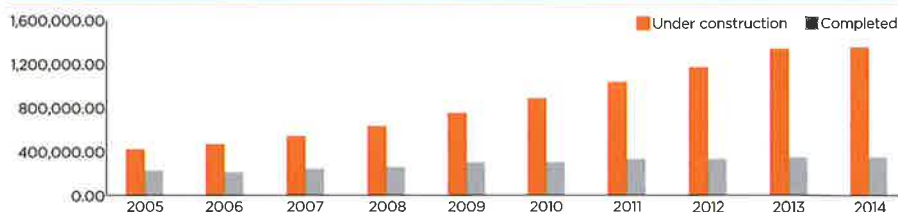
resultant materials can have a high strength, high fracture toughness, high density and more, suiting it to a range of specialised applications.

Zirconia can therefore find applications not only in casting and moulding but in grinding media, piezoelectrics, nanotechnology, optical materials, memory devices, fuel cells, catalysts as well as biosensing and biomedical applications.

The number of new uses for zirconia will continue to increase thanks to its relative abundance in nature and mining, as well as its innate characteristics. While low-grade stabilised zirconia has been widely used in refractories, pigment coatings and pottery colours for a number of decades, it has only been during the past 40 years that technical-grade zirconias have been produced for more advanced applications.

A recent example is one from Zircoa GmbH, which in September released its long-awaited Black Diamond product, used for tooling, milling media, mud pump liners, wire drawings or similar applications. A shift in the company's philosophy in 2014 meant that R&D became proactive rather than reactive, resulting in a product that has a good fracture toughness, is hard and dense,

Floor space of building under construction and completed in China



Historically, the growth of consumption in ceramics has been largely driven by tile demand. Growth in tile production can be linked to construction activity, with the highest rates of construction presently in Asia, especially China. The graph shows that while construction in China appears to be rising, the amount of buildings completed has remained relatively stable.

Source: China Statistical Yearbook, 2016

and compares favorably in most aspects to the widely used material, Ytria Stabilized Zirconia.

In his 2016 review on Solid Oxide Fuel Cells (SOFC) for the 21st Century, Kevin Kendall, Professor of Chemical Engineering, University of Birmingham, makes a bold prediction for the future of zircon demand. His quote is representative of the potential demand to arise out

of the swathe of research currently going on across the world of zircon, zirconia and zirconium:

“there is little doubt that large quantities of zirconia will be needed for the SOFC application in the years to come, with annual production rising to more than 1m tonnes (equivalent) a year in 2100, rather as titania expanded in the last century for pigment applications”.

ZIA confident on zircon supply demand trajectory

With questions on zircon's supply-demand trajectory, given the bold predictions by the SOFC survey, *Siobhan Lismore-Scott, IM Consultant Editor*, speaks to *Keven Harlow*, executive director of the Zircon Industry Association, about the body's expectations for the future



Have you/the association noted a shift in demand?

We have seen that, overall, the underlying demand for zircon is growing moderately; however, with some regional differences: for example, after several years of depressed consumption, Europe is improving and the US is ready to recover, albeit timidly. India is the bright spot in the zircon world, while China remains flat due to plant closures following environmental inspections that the government is implementing strictly.

New sources of supply or different grades needed?

ZIA believes that the market is in balance, but current mines will progressively face grade and production decreases over the next few years, so new mining projects will always be necessary to avert a shortfall as any remaining inventory is gradually consumed.

Has the downturn in steel markets affected the industry at all?

Zircon usage in the steel industry is much smaller than for ceramics in total zircon consumption. That said, zircon demand in foundry and refractory applications has been negatively affected by the downturn in steel markets. On a qualitative side, we have seen that higher quality refractories, which demand more zircon, are increasingly used to lengthen the refractory life-time – an example of the properties of zircon adding real value.

Where is growth expected (in terms of location) and why?

The ZIA is constantly monitoring both R&D and the industry, looking for opportunities that might promote additional consumption of zircon. New applications are being discovered all the time, but ceramics will remain the main driver of global zircon consumption.

As more developing countries grow, their middle class and infrastructure also develop, leading to increased demand for ceramics. India currently shows a high growth level, and more nations in the Middle East, Africa, and South East Asia are expected to contribute positively, either through their own local industry, or by importing ceramic products from the existing exporting countries.

Are there concerns over substitution at all?

Substitution is always a concern, but the ZIA promotes zircon as having many attributes beyond price, and as a product that delivers substantial added value. Substitution occurred in the past when price increased excessively; however, we are now in a relatively low-price environment and producers seem to show restraint. There will always be adjustment of formulations depending on material prices, but zircon has several unique properties (opacity and whiteness, hardness, low thermal expansion, high melting point, thermal conductivity, chemically inert, low neutron absorption) that are able to be valued through the life cycle.

Or about new sources of supply flooding the market?

ZIA believes that currently the market is balanced with sufficient inventory to meet any jump in demand. Remember that there is a long lead time for new projects to come on stream, so it is very unlikely that the market will be flooded. We are also in an economic environment that's different from the previous peaks and troughs of the zircon cycle. If new entrants do enter the market, this will temper any downstream user concerns of a possible shortage of raw materials. And new production will be required to replace mines that will gradually be depleted.