

Sorting SiC micro grits

Demand for specific micro grits in high-end applications, such as silicon wafer cutting, has forced silicon carbide producers to focus more than ever on process routes. Here **IM** examines the operations of US SiC producer Washington Mills

WASHINGTON MILLS ELECTRO Minerals Co., headquartered in Niagara Falls, New York, USA, is one of the largest producers of silicon carbide (SiC) in the world. It has a production capacity of some 60,000 tpa of crude SiC, which is spread between its plants in Orkanger, Norway, and Hennepin, USA.

The company manufactures SiC through the traditional batch Acheson furnace process as well as large furnace technology. Washington Mills believes that by operating both technologies, it has greater flexibility in its crude production, but also deeper technical expertise.

Washington Mills is part-way through a 10,000 tpa crude capacity expansion at its Hennepin plant, which the company initiated in 2007 (see *IM July '07*, p.6).

Anne Williams, marketing manager at Washington Mills, said of the facility: "Our Hennepin plant was designed for the large furnace technology that collects and cleans the off-gases from the silicon carbide manufacturing process."

"We made a significant investment in our environmental technology because we believed in the facility and we were certain that there would be tighter environmental controls placed on the silicon carbide industry around the globe in the future," Williams revealed.

Market applications

Washington Mills has built a reputation as manufacturer of large volumes of high quality micro grits for the photovoltaic industry and for the production of diesel particulate filters (DPF).

Washington Mills has a capacity of around 25,000-30,000 tpa of SiC

micro grits and produces more than 20 different products to suit different specifications.

In particular, abrasive micro grits are sought by wire saw users. In this application it is critical that the micro grits slice the silicon wafers cleanly and efficiently to produce high quality wafers, but also to control kerf loss. Shape, chemistry and sizing are all factors that make up how well the micro grits cut the silicon metal.

There is a tangible advantage to providing a consistent high quality product for wire sawing applications. More efficient and better performing micro grits reduce total SiC consumption and reduce silicon metal loss, resulting in cost savings and a more efficient manufacturing process. The risk of using poor quality micro grits can be an expensive gamble given the high price of silicon metal.

Processing

Many variables can influence the quality of the micro grit, but the quality of the crude material is one of the most important factors. The chemistry and crystal structure of SiC is largely determined in the crude manufacturing process. However the main factors that impact quality include: the raw materials (sand and a carbon source), design and running of the furnace, and the cleaning and separation processes.

Williams commented: "It is for these reasons that Washington Mills' skill and experience in crude manufacturing is a large advantage and influences the total performance of the SiC micro grit. By controlling the inputs, we are able to consistently produce a better quality product."

From the furnaces, crude SiC material goes through the cleaning, sorting and pre-crushing processes, before



A carborex-grade SiC furnace operated by Washington Mills, on-line at more than 2,000°C.
Courtesy Washington Mills AS



High-end applications, such as wiresaws for solar panel and silicon wafer cutting, have tightened supply for SiC's traditional markets in abrasives and refractories. Courtesy US Green Energy Center

being separated into different product groups. Once sorted into groups, the SiC is washed and then goes through the comminution process through a series of crushers and mills.

After this, SiC is processed via magnetic separation, which removes excess iron from the crushing process. Then the material undergoes further milling and classification to ensure the production of closely sized micro grits. The entire process is computer controlled and is managed from a central control room.

Market conditions

"Sales are predictably down in Q1 2009 – mirroring the overall recession trend line across abrasive-consuming industries. SiC micro grit sales specifically are down but have fallen to a lesser degree than other, similar products," said Williams.

Like many industrial minerals that are consumed or bought based on the health of the automotive and construction sectors, the amount of SiC consumed by producers of DPF has fallen, as these

producers have had to cut back on the number of filters they manufacture. Meanwhile, sales of photovoltaic wire saw grits have also slowed, but not to the same degree as ceramic products for the automotive sector.

This situation is almost a polar opposite to the supply-demand scenario in 2008. Last year, there was a deficit of SiC – demand was high and strong future growth was forecasted. Many suppliers had thus kept an ample inventory of silicon carbide, to ensure that the growing number of orders could be met. When the economy slowed down, the focus shifted to reducing inventories, generating cash and minimising purchases.

Williams commented: "What we've been experiencing is the same across most of the manufacturing industry – customers are holding off on purchases until they absolutely have to replenish their inventories. We can't predict any better than our customers as to when the economy will pick up again, but we're positive that when it does, the demand for silicon carbide will resume to 2008 levels."

SiC production

Silicon carbide, or SiC, is commonly known by the trade names *carborundum* and *crystolon*. SiC is produced by fusing high-grade silica sand with carbon in an electric furnace, at temperatures of up to 2,200°C. The time of a run is about 60 hours – 36 hours for heating, and 24 hours for cooling.

The preferred source of carbon for SiC is petroleum coke, although anthracite and coke from low ash coal may be used. High iron and alumina found in the ash are undesirable as they may promote the formation of elemental graphite and metallic silicon during fusing.

Silicon carbide is a valuable industrial mineral, and specific micro grits for high-end applications command high prices. The latest prices from **IM** show silicon carbide (FEPA 8-220, CIF UK, black) about 99% SiC, at \$1,700-2,100/tonne, while SiC Grade 1 and SiC Grade 2 are worth \$1,700-2,100/tonne and \$1,500-1,700/tonne, respectively.