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HICON®

EBNER GROUP Journal for technology and progress

EBNER GROUP

Ladies and Gentlemen, esteemed readers of the HICON® Journal, dear friends and colleagues of the EBNER GROUP!

The constantly increasing rate of growth of the **EBNER** GROUP has led it to divide its activities into two business units.

Business unit *THERMAL PROCESSES* includes well-known names from our classic field of activity, heat treatment. The unit includes Group members **EBNER**, **EED**, Gautschi, GNA, HPI and Hazelett.

Business unit *ADVANCED MATERIALS* is involved in a new business sector, crystal growth for the semiconductor industry. It includes **FAMETEC**, Arctic Sapphire, **EEMCO** and SICREATE.

These companies are all operating independently of the traditional **EBNER** focus on furnace design, are involved with different materials such as sapphire and silicon carbide, and are in the market not as equipment manufactures but as producers.

EBNER Industrieofenbau has proven itself to be a reliable and competent partner in industrial plant engineering, and this experience can now also be put to good use in the new business sector being developed by the *ADVANCED MATERIALS* business unit.

In the *THERMAL PROCESSES* unit, which over the course of the year has already been awarded many exciting projects, we have further increased our investment in research as part of our efforts to remain true to our role as the technology leader, fulfill the increasingly strict requirements of our customers and always be able to offer the latest technologies. In our research, a strong focus is being placed on increasing both efficiency and sustainability.

The **EBNER** GROUP will attend both the *ALUMINUM USA* trade fair in Nashville, Tennessee (October 25 - 26, 2023) and the *SEMICON EUROPE* trade fair in Munich, Germany (November 14 - 17, 2023). We look forward to having many interesting discussions with you there.

Yours, Robert Ebner
CEO **EBNER** GROUP

P.S.: For an overview of the products and technologies of the **EBNER** GROUP, please take the time to watch our new **EBNER** GROUP video!

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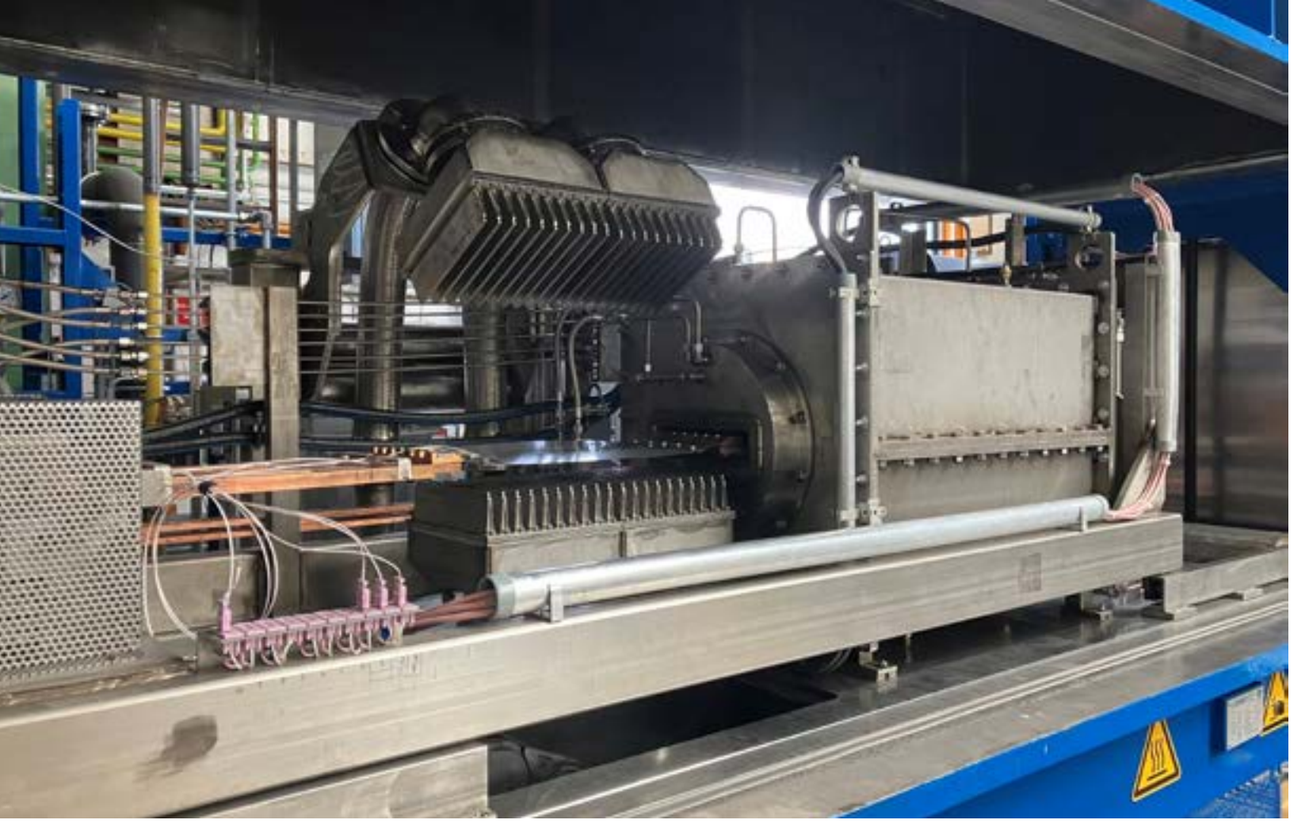


Research & Development.

EBNER's continuous R&D efforts ensure that customers always have the most advanced technology available.

PETER SEEMANN
EBNER Product Manager Aluminum

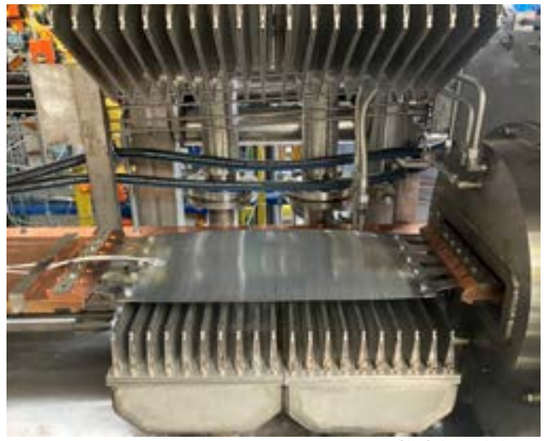
In our THERMAL PROCESSES business unit, EBNER Industrieofenbau is continuously seeking to advance and improve technologies to increase efficiency and promote sustainability.

Two current R&D projects that may be of interest are described below.

SIMCAL GEN5

Many of the heat treatment practices employed by our customers require continuous processes, as rapid heating-up or rapid cooling is needed. Technology is often the deciding factor in the choice to use a continuous heat treatment process, although logistical issues or throughput requirements may also play a role.
SimCal Gen5 is a heat treatment simulator that allows a broad range of annealing cycles at a continuous heat treatment facility to be reproduced. A wide variety of materials such as electrical steels, stainless steels and titanium alloys with thicknesses ranging from 0.05 mm to 5 mm can be heat treated.

Heating can be carried out using a combined heating system or a muffle, and may employ either radiant heat or an electrical resistance heating system. Test temperatures up to 1100 °C can be achieved. A gas quench using hydrogen gas provides cooling rates up to 100 K/s with a strip thickness of 1 mm. Specified strip tensions can also be applied to samples with pneumatic cylinders. This enables the simulation of mechanical loads on the material during the heat treatment process. Finally, a variety of process atmospheres can be selected for use in the workload space such as hydrogen, nitrogen, predefined hydrogen/nitrogen mixtures, argon or helium.



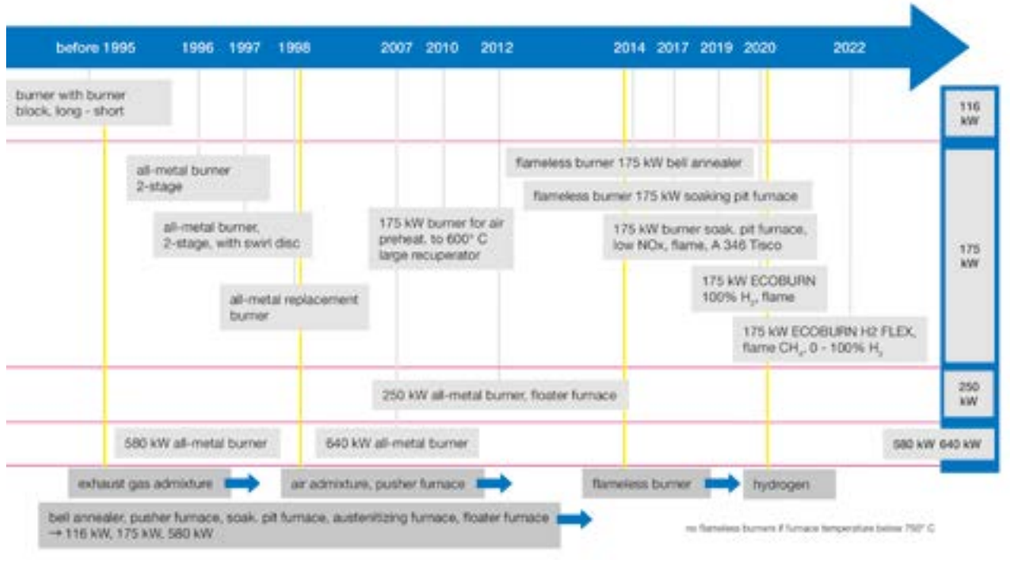
SimCal sample in use

ECOBURN H_2 FLEX

It is hard to imagine our daily lives without metals. For this reason, the idea of "sustainability" plays a particular role in the manufacturing chains for metal products, and it is our duty to act in an environmentally-friendly a manner as possible. A particularly energy-intensive element in manufacturing is the burner, which has already been the subject of many developments and optimizations at EBNER.
We began development of an eco-friendly burner back in 2020.

- 2020: Development of the ECOBURN H_2 burner, designed for combustion with 100 % hydrogen, begins
- 2021: Completion of development, including laboratory tests with H_2 and natural gas
- 2021: Intensive efforts are made to test the burners at customers' works, but these efforts fail due to the limited availability of hydrogen
- 2022: Customer feedback indicates an increased need for mixed-gas operation, with a mixture between 100 % natural gas and 100 % H_2
- 2022: Development of the ECOBURN H_2 FLEX burner, based on the ultra-low NOx burners installed at the Tisco vertical strand annealer (facility A346), begins
- 2022: Completion of development, laboratory testing of combustion in both natural gas and hydrogen modes
- 2022: Discussions with a German customer regarding field testing
- 2023: Adaptation of the burner for flameless operation
- 2023: Successful testing of flameless operation with both natural gas and hydrogen
- Initial field testing has been taking place at a customer's works since September, 2023

A history of burner development



Aluminum experts

As experts in the aluminum industry, the EBNER GROUP hosts a symposium for the Chinese market.

YU JIAN

Senior Sales Manager - EBNER Industrial Furnaces Taicang

YAO CHUNMING

Senior Sales Manager - EBNER Industrial Furnaces Taicang

Following three years of pandemic, China's aluminum processing industry has changed significantly. As a pioneer and market leader in the field of heat treatment for the aluminum industry, the EBNER GROUP held a technical symposium for the Chinese aluminum industry.

The symposium took place on July 4, 2023 at EBNER's offices in Taicang, China. Almost 40 experts from companies well-known throughout the Chinese aluminum industry took part. As a full solution provider for the heat treatment of aluminum products, the EBNER GROUP has a full portfolio of technologies from brand names such as EBNER, EED, Gautschi, GNA, HPI and Hazelett. It can offer its customers solutions along the entire value-added chain associated with the heat treatment of aluminum products.

Within the framework of the symposium, the products and technologies of the different companies making up the EBNER GROUP were introduced in detail.

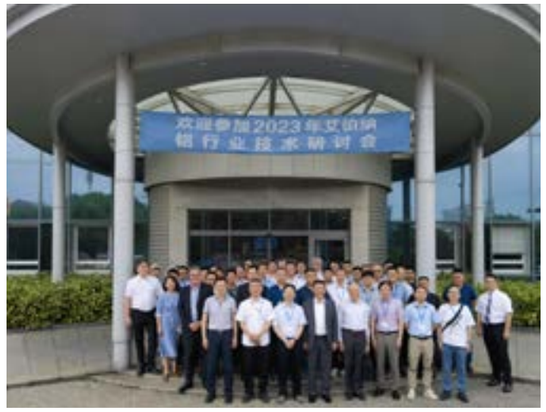
These include EBNER heat treatment facilities for aluminum plate, strip and foil, Gautschi technologies for melting, casting and recycling aluminum, HPI's horizontal casting technology, Hazelett's continuous casting and rolling lines, facility solutions from GNA and EED to heat treat aluminum profiles and the new generation of EBNER FAST heat treatment lines for aluminum strip.

The transformation of the international political climate that followed the pandemic, along with the reaction of the market to changes in demand, have highlighted the competition within the Chinese market.

However, while customers in the aluminum industry are concerned about the changes in the market that developed after the pandemic, they still show trust. Industrial modernization still points out the path of development for Chinese aluminum processing companies.

Chalco Group, Weiqiao Pioneering Group, Mingtai Group and other companies have announced they are experiencing an increased demand for high-end products, and they have appropriate plans for future investment.

The symposium contributed to a better understanding of the composition of the EBNER GROUP among the experts that were present, as well as the technologies and solutions the Group offers. The exchange of ideas on technical issues underlined the high expectations placed on the EBNER GROUP.



EBNER hardening and tempering technology for aluminum plates.

Efficiency, temperature uniformity, quench technology and high quenching rates: these are the key characteristics EBNER roller-hearth furnace facilities are provided with to fulfill the strict requirements of the aerospace industry.

ANDREAS STEINMASSL
EBNER
VP Sales Aluminum

MARKUS GANGL
EBNER
Senior Product Manager Aluminum

For years, the requirements placed on aluminum plates used to manufacture aircraft components with the durability to be exposed to high stresses have been the driving force behind the rising quality and process reliability of aluminum production. Prominent examples of this are the provisions of the AMS 2750 standard for heat treatment, which form a challenging package of requirements that must be fulfilled by the suppliers of furnace technology. EBNER stands out as a technology leader in this field, as difficult approaches to requirements represent ideal challenges for us to face.

The first EBNER roller-hearth furnace to solution heat treat aluminum plate went into operation over 30 years ago. Even back then, the quality requirements placed by the aerospace industry were taken into account and fulfilled. Nevertheless, since that time the technology has been strongly advanced through close cooperation between the EBNER R&D team and the EBNER Engineering Department. A significant role was also played by the close tailoring of development to our customers' needs. Continuously rising requirements provided the input we needed to focus ourselves on the necessary core technologies.

Factors determining the quality of a finished plate include temperature uniformity and rapid, even quenching in a water quench. We placed our primary focus on these two parameters and developed a clear competitive advantage.

To achieve temperature accuracies better than ± 2 °C during soaking, each furnace zone was divided into eight temperature control zones that could be regulated individually. In addition to the granular subdivision of heating zone temperature regulation, EBNER developed a precise process cooling system that compensated for excess energy in the process and prevented even minimal spikes in temperature. This system works hand in hand with the principles of the proven EBNER HICON high-convection system. Large, high-pressure impellers are powered by frequency-controlled motors with an energy efficiency class of IE4. This system ensures that the furnace atmosphere has an extremely high circulation rate, and the resulting high speeds at the air emission nozzles provide superior heat transfer coefficients.

As soon as the soaking time has expired and the solution temperature has been reached, the quenching process starts. An EBNER quench is comprised of three main zones: the high-pressure quench, which provides the critical cooling of the plate down to below abt. 200 °C, the low-pressure quench, in which cooling is completed and any reheating of the plate due to residual energy in its interior is prevented, and finally the dryer, where any remaining water is removed from the plate.

Decisive in determining the metallurgical characteristics of the plate is the first quenching step, which at EBNER roller-hearth furnaces is carried out in the high-pressure quench. The height of an EBNER high-pressure quench is adjustable, meaning that the process is extremely flexible and can be adapted to widely different plate thicknesses. The plates are quenched symmetrically from above and below, with identical distances between the surfaces of the plate and the nozzles. This symmetry ensures extremely uniform quenching throughout the entire thickness of the plate. The special arrangement of the high-pressure nozzles also helps ensure the uniformity of quenching across the plate, as the nozzle array of the high-pressure quench ensures that the cooling rate remains linear across the width of the plate. Yet another significant advantage is that, due to the high pressures that are used, the film of water that forms on the plate is constantly penetrated. In contrast to conventional quenching systems, fresh cold water is repeatedly applied to the surfaces of the plate and a Leidenfrost (vapor film) effect is prevented. All of these quench features ensure homogeneous metallurgical characteristics, which are reflected in the results of conductivity tests.

To increase the energy efficiency of the system, EBNER roller-hearth furnaces can also be equipped with charging roller tables that enable hot plates (plates that retain residual heat from the rolling process) to be charged. As may be expected, higher temperatures at the furnace entry result in shorter heating-up times and so reduce energy consumption.

To sum it all up, one can say that EBNER roller-hearth furnaces are currently the technical and technological benchmarks for the industry. Additional developments and concepts are already in the design phase, and our R&D and engineering teams are working hard to refine them and make these new systems ready for the market.

SICREATE – the expert in silicon carbide powders.

The new generation of high-quality SiC powders for the semiconductor industry

DAVID CALLEJO
SICREATE
Technical Managing Director

ROBERT PETER EBNER
SICREATE
Commercial Managing Director

SICREATE, founded in 2021, specializes in the development and production of silicon carbide powder. This powder is used as a raw material in various applications in the semiconductor industry.

Our dedicated team of researchers and technicians works out of the headquarters of the **EBNER** GROUP in Leonding, Austria, as well as our R&D Center in Lomagna (LC), Italy.

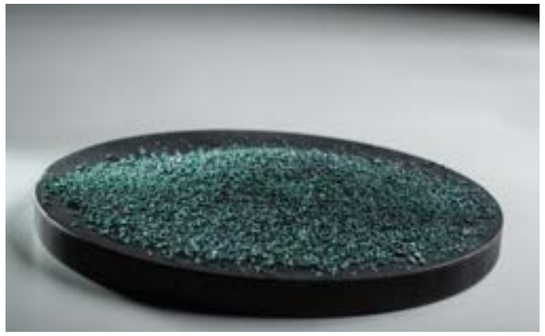
As part of the **EBNER** GROUP, the company supplies **EEMCO** (also a member of the **EBNER** GROUP) with material and thus benefits from the presence of a close partner for the continuous development and improvement of SiC powder.

As an economically-competitive European manufacturer, SICREATE contributes to the sustainability goals of the **EBNER** GROUP with a resource-conserving production process and thus an environmentally-friendly product.

SICREATE PRODUCTS

SICREATE is able to produce 2 types of SiC powder at a 6N purity level and with a grain size of 0.1 mm - 2 mm, in the colors green and light gray. The green powder is conductive (N < 30 ppm), while the light gray is semi-insulating (N < 1 ppm). SICREATE's high quality standards are reflected in the fact that no mechanical or chemical post-treatment of the powder is performed, with the purity level and granulometry achieved during a single production cycle. Compared to other silicon carbide powders available on the market, SICREATE's powder features versatile granulometry, low stable nitrogen content, the lowest possible amount of metallic impurities and no chemical impurities, and a low CO_2 footprint.

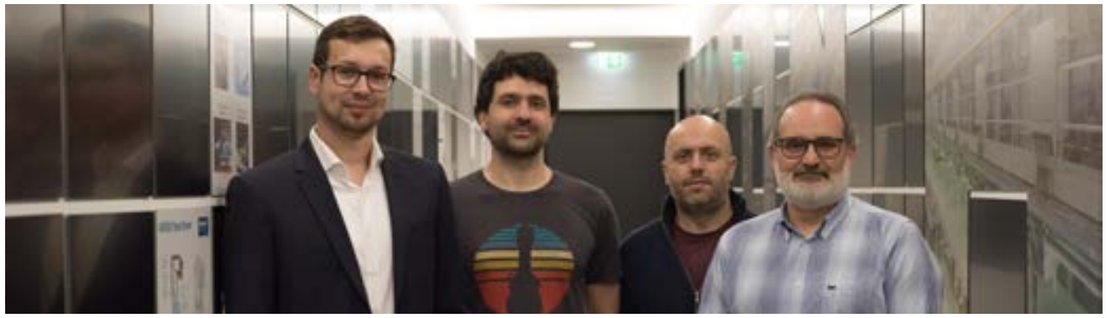
In the spirit of promoting circular economy, SICREATE offers recycling of customer raw material to produce new, high-purity silicon carbide powder that can be reintroduced into the semiconductor supply chain.



SiC powder from SICREATE

SICREATE TECHNOLOGY

SICREATE produces its material using an ultra-high vacuum silicon carbide sintering process. This process is characterized by a high-temperature solid state flash reaction in an ultra-high vacuum atmosphere. Also of note is that this is a single step sintering process without any post-treatment, either mechanical or chemical.



SICREATE MARKETS

SiC powder is used in a variety of applications in a number of markets. They include, for example, technical ceramics, defense and security, automotive, electronics and aerospace.

TECHNICAL CERAMICS

Silicon carbide is an attractive material for a variety of technical ceramic applications due to its specific properties such as chemical inertness at all temperatures, thermal shock resistance, abrasion resistance and sinterability. The main applications of SiC in the technical ceramics industry are the manufacture of kiln furniture, fluid handling equipment, bearings and wear parts, as well as ballistic protection and diesel particulate filters.

ELECTRONICS

The specific properties of silicon carbide make it an attractive material for a wide range of electronic applications. The main application of SiC powder in the electronics industry is the manufacture of kiln furniture and process components for the semiconductor industry, as well as for electrical field grading and surge protection.

AEROSPACE

In the aerospace industry silicon carbide is used to create both mirrors and structures, as the properties of silicon carbide make it a desirable choice for these end products. Silicon carbide is lightweight and rigid, making it particularly suitable for use in aircraft and space vehicles. It is also resistant to thermal shock, preventing mechanical fatigue and damage from extreme temperature changes. Over and above these advantages, silicon carbide is resistant to moisture absorption and the deterioration caused the radiation encountered in space. These properties make it a strong contender in the aerospace industry, well able to compete with materials such as beryllium for use in mirrors.

EEMCO: your European source for silicon carbide.

The next generation of energy-saving, high-tech materials for the semiconductor industry.

STEFAN DEFREGGER
EEMCO
Chief Technology Officer

EEMCO was founded at the end of 2020, and is a part of the EBNER GROUP's ADVANCED MATERIALS business unit.

Over the course of 12 years of research and development work dedicated to the design and manufacture of crystal growth equipment, our company successfully developed dedicated furnace facilities designed to grow SiC single crystals with the 4H process. In the meantime, we have taken the next steps toward the manufacture of 8" 4H SiC single crystals. These crystals are used in high power applications, particularly those found in the automotive, industrial and renewable energy sectors.

EEMCO currently operates 15 research furnaces, in which SiC single crystals are grown using a PVT (Physical Vapor Transport) process. In such a process, a single crystal is grown in an SiC vapor phase. EEMCO's goal is to be the first independent company in Europe to produce these types of SiC crystals and be a manufacturing source for these strategic, high-tech products, offering a high-quality alternative to suppliers in the USA or China. As a sustainable product that saves energy, SiC is making a significant contribution to the reduction of CO_2 in a wide variety of market sectors and consumer products.

EEMCO PRODUCTS

EEMCO specializes in the manufacture of high-quality 6” and 8” pucks, using proprietary furnaces and process technology.

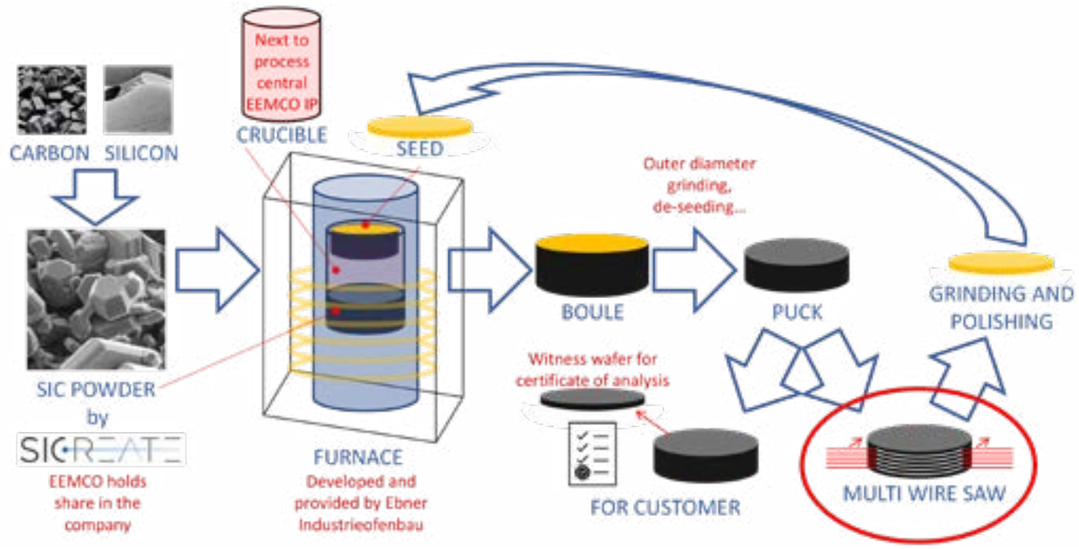
EEMCO furnaces

Compared to 6" wafers, 8" wafers offer a significant increase in capacity: they provide almost twice the usable area for manufacturing integrated circuits, delivering from 1.8 to 1.9 times as many chips. Over and above this, EEMCO fulfills the requirements for thin wafering technologies and so reduces the wafer thickness by at least a factor of three.

Among the essential criteria for the economical use of SiC single crystals is the lowest possible density of defects in a single crystal. However, at the same time wafers must be as large as possible (a 6" wafer is now standard, with 8" wafers soon to be introduced). This requires an absolute mastery of the complex technology for crystal growth, as provided by EEMCO.

EEMCO TECHNOLOGY

EEMCO technology is centered around the development of a process model for 6" and 8" pucks. We use only SiC powders and granulates that we have developed ourselves.



EEMCO MARKETS/APPLICATIONS

AUTOMOTIVE INDUSTRY

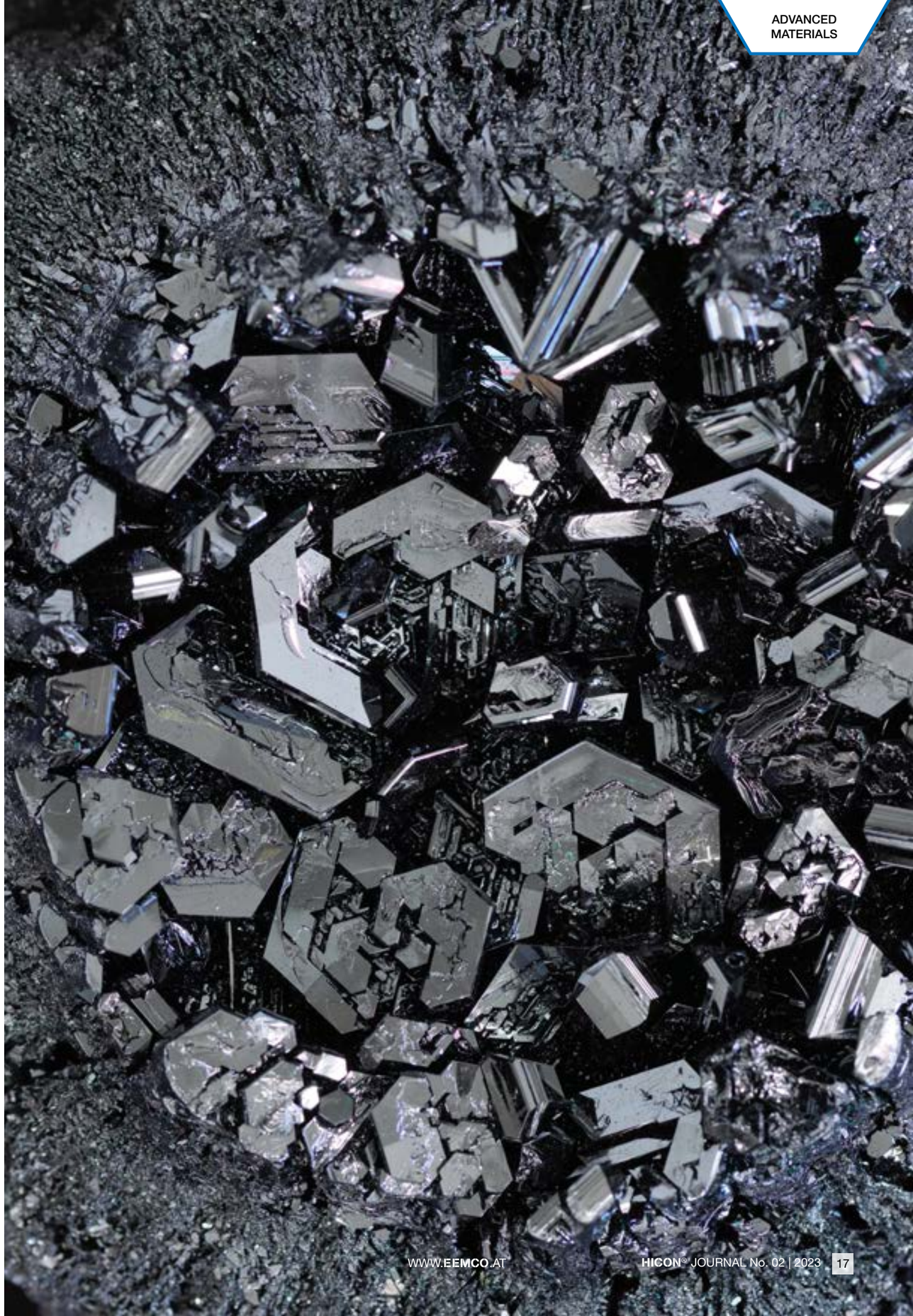
The demand for electric drives in motor vehicles has been increasing rapidly, and with a market share of over 60 % they are by far the most significant factor in the market for high power electronic devices. In turn, this has created an increasing demand for highly-efficient semiconductors for use in electric/hybrid vehicles (EV/HEV). The higher efficiency and power density provided by SiC lead to increased ranges, better-dimensioned systems and faster charging times. Typical applications include highly-efficient inverters, on-board charging electronics, boosters and DC/DC converters.

HIGH POWER ELECTRONICS

Auxiliary power supplies are needed in a wide variety of industrial applications. Among other uses, these applications include drive motors, inverters and industrial manufacturing equipment (including robotics). With its unique properties, SiC has greatly contributed to improvements in the energy efficiency, reliability and performance of these systems. Typical devices using SiC-based technology range from Schottky diodes (also called Schottky barrier diodes, or SBDs) to junction-gate FETs (or JFETs) and MOSFETs. In fact, SiC SBDs are widely used in IGBT power modules and power factor correction (PFC) circuits. In these applications, SiC does not just increase efficiency - it also reduces cooling requirements. It also simplifies device design, in that it reduces the number of passive components and enables simpler designs - without sacrificing performance. These characteristics are also very useful in the IT industry, particularly in data centers.

RENEWABLE ENERGY

Solar power, wind power and renewable energy storage are market segments that display remarkable growth. While renewable energy has been a favored application for SiC products for many years, ongoing climate and energy crises have increased the demand for alternative energy sources even more. Common applications again involve high-efficiency electronic power devices like inverters and boosters (power converters), as well as essential components for power conversion and energy storage systems. Typical charging losses for such devices range between 6 and 9 %, values that can be dramatically reduced by applying SiC technology. SiC-based device technology also reduces the need for complex circuit designs, requiring fewer overall components and minimizing charging losses.



GAUTSCHI MASTERmax.

ALUMINUM RECYCLING for dross and scrap with high organic content.

STEFAN PELECH

Casthouse Revolution Center
Group Vice President
Aluminum

Remelting metallic aluminum requires 10 to 15 times less energy than producing aluminum metal from bauxite. This is reason enough to collect every bit of aluminum that is unused or cannot continue in use and add it to a melting process. Every kilogram of aluminum that is collected prevents the emission of around 15 kg of CO_2.

SCRAP

Depending its original application, aluminum scrap may come in a wide variety of shapes and bring with it a wide variety of contaminants. It must therefore be sorted and cleaned as thoroughly as possible before it can be placed in a melting furnace. If the scrap is in large pieces and free of organic contaminants, it

Since it was founded in 1922, Gautschi Engineering GmbH has numbered among the most innovative and competitive full-solution providers for aluminum melting and casting processes.

can be melted in a single-chamber furnace such as the GAUTSCHI type SRF (*Schmelzofen Rund Feststehend* or "melting furnace, oval, fixed hearth") or type SVF (*Schmelzofen Viereckig Feststehend* or "melting furnace, rectangular, fixed hearth") furnaces.For scrap that is either in large (profiles, plates, cast parts) or small pieces (chips, shredded can scrap) and contains trace amounts of organic contaminants such as oil, paint or plastic, specially-adapted multi-chamber furnaces are often the best choice. An example of such a furnace would be the GAUTSCHI SMF (*Schmelzofen Mehrkammer Feststehend*, or "melting furnace, multi-chamber, fixed hearth").

DROSS

Aluminum oxidizes very rapidly, particularly when it is hot and in a liquid state. This causes a skin of alumina (aluminum oxide) to form on the surface of the molten metal in a melting furnace. This skin is called "dross", and is either removed or skimmed off before processing is continued. Alumina is porous, and absorbs metallic aluminum like a sponge. For this reason, a large percentage (30 - 70 %) of the dross is comprised of metallic aluminum that should be recovered if possible.

INNOVATIVE ALUMINUM RECYCLING FOR A SUSTAINABLE FUTURE

For dross and scrap with high levels of organic contaminants, materials that are particularly difficult to melt, rotary tilting furnaces (RTF, in German DKO or *Dreh-Kipp-Öfen*) are used. In these furnaces, the charged material is mixed with a salt flux in a manner similar to a cement mixer and heated. This allows the charge to be melted in a controlled manner, providing higher yields. The GAUTSCHI MASTERmax is the product that rounds out aluminum recycling needs. Developed by KMF, this rotary tilting furnace is extremely well-suited for melting can scrap, dross and chips. By continuously measuring the temperature of the stream of exhaust gas and allowing the melting process to be optimized through the injection of oxygen, this RTF achieves the highest possible efficiencies - maximum metal yields paired with minimal energy consumption. Instead of natural gas, the organic contaminants that enter the furnace with the scrap are used to supply energy used for the melt in the furnace.

EFFICIENCY AND PERFORMANCE GO HAND-IN-HAND

This rotary furnace does not just impress with the small amount of space it requires. Also impressive is its robust design, which enables it to operate day in and day out in the most demanding casthouse environments. Using the melting recipes stored in the MELTmax control system, operators can automate the entire process in a controlled manner. As dictated by the guidelines of Industry 4.0, the control system ensures that the composition of scrap is defined and that melting programs are individually tailored to suit that composition. This ensures that the balance between energy consumption and melting performance is maintained..

ADAPTABILITY FOR VARYING REQUIREMENTS

Experienced operators can manually fine-tune the performance, while newer ones are assured of reproducible yields and highly stable processes thanks to the high degree of automation and the melting recipes. The hybrid design of the MASTERmax system enables to the furnace to be operated with a wide variety of melting processes, including:

- A salt process with a fixed horizontal axis, during which enough salt flux can be added to liquefy the slag. This measure is necessary when the scrap has particularly thin walls.
- A low-salt process with a variable axis (tiltable), during which a "crumbly" dry slag forms. This dross can be tipped out of the furnace at the end of the cycle.
- A salt-free process, which is of particular use when recycling uncontaminated dross.

INTELLIGENT AUTOMATION AND FLEXIBILITY

The melting unit, with technical features designed to allow a maximum amount of automation, provides reproducible results paired with the highest possible yields and optimized thermal efficiency. Precise weighing of the furnace in real time, along with continuous measurement of the temperature of the molten metal, are unique features that provide a degree of automation that is significantly higher than that of competing products.

Another unique approach taken by the MASTERmax is the ability to draw out liquid metal in a controlled manner through a tap hole in the furnace floor, while the furnace door remains closed. This minimizes oxidation and keeps the temperature of the aluminum constant during the entire tapping procedure. All process data can be integrated into the casthouse control center, or called up out of the control system individually using charge reports.

SIZES AVAILABLE IN THE MASTERMAX SERIES

Furnaces in the GAUTSCHI MASTERmax series are available in five sizes. They range from a compact, entry-level model like the 1TR2, with 2 MW burners and a 4-ton capacity, to the powerful "Jumbo RTF", which is equipped with 5 MW burners and which can supply an impressive 50 ton of molten aluminum.

THE ADVANTAGE OF MASTERMAX: PRACTICAL INNOVATION

Due to the innovative double-pass system for exhaust gas, a thermal outburner is not standard required equipment. With the system, up to around 8 % of the aluminum scrap that is processed can be organic components (oil, paint, plastic). A thermal burnout system can, however, be added as an optional extra to better comply with local environmental regulations, even if scrap with even higher percentages of organic components is to be charged. The infinitely variable flame length of the burner optimizes energy consumption, and ensures a uniform temperature distribution, The adjustable tilt of the furnace drum, which can be varied between -8° and +25°, allows optimal use of the furnace geometry. The fully automatic, fully rotating (360°) charging cradle evenly fills the furnace along its longitudinal axis and ensures that the charging procedure is virtually airtight, even as it protects the refractory lining at the same time. Capacities of up to 7 tons per load allow optimal timing. The short charging times that result minimize the exposure of the melt to ambient air, and so reduce the amount of oxidation of the metallic aluminum. Tapping below the slag, with the rotating drum tilted, maintains the purity of the aluminum. An exhaust gas hood that tilts with the furnace prevents the escape of exhaust into the casthouse while the slag is being poured out.

COOLING THE SLAG

Slag - the residue of the rotary furnace process - is comprised of alumina, a greater or lesser amount of salt flux (NaCl or KCl) that depends on the melting process that was employed, and other metal oxides. As the metallic aluminum and slag cannot be 100 % separated in the rotary furnace, around 10 % of the slag is typically composed of metallic aluminum after the furnace cycle.

After tilting, the slag has a temperature of 1000 °C or more. If the slag is allowed to remain in the slag container, the metallic aluminum will continue to oxidize. This can be recognized by the fact that the temperature of the slag will rise even further. Oxidation will continue until there is no metallic aluminum remaining, but can be stopped if the slag is cooled down to below 400 °C. The faster this can be carried out, the more metallic aluminum will remain in the slag. This aluminum can subsequently be recovered using an eddy current separator.

The COOLmax slag cooler developed by KMF requires only a few minutes to cool the slack down to the required temperature of 400 °C. At the same time, the slag is ground into grains of a size that allows aluminum "nuggets" to be separated out of it later using eddy currents.

CARBON CONSIDERED

Throughout the world, aluminum casthouses create an estimated 4 million tons of dross. If we assume a metal content of ~ 50 %, the recycling of dross would reclaim about 1.7 million metric tons of aluminum. The rapid cooling of slag would allow an additional 300,000 metric tons of aluminum to be reclaimed.

Two million metric tons of secondary aluminum instead of the same amount of primary aluminum means a savings of almost ~ 30 million metric tons of CO_2 per year. 4.5 million metric tons would be provided by the adequate cooling of slag alone!

The Hazelett aluminum strip casting process

DAVID HAZELETT
Hazelett Managing Director

HAZELETT
EBNER® GROUP MEMBER

Since 1919, Hazelett has been a world leader in the development and manufacture of continuous casting machines for the metals industry.

Aluminum strip and sheet are manufactured from cast slabs or strip in either a charged process or a continuous casting process. Hazelett's process of choice is continuous casting, in which a Hazelett twin-belt casting facility is used.

The image on the lower right-hand side of page 23 shows the most important steps in the processing of aluminum to strip and sheet. Conventional direct chill (DC) casting is the first process shown, and the number of processing steps that this involves can easily be seen. They include preparation of the molten metal and alloying, DC casting, sawing, machining, preheating of the rolling ingots and hot rolling (both roughing and finishing). The hot rolled strip is then cold rolled to reach its final dimensions.

In comparison, the path taken in a continuous casting process is much shorter. Two continuous casting processes are important in the manufacture of aluminum strip and plate: twin-roll casting and twin-belt casting. In twin-roll casting, the processing steps include the preparation and alloying of the molten metal, casting and winding. The strip is then cold rolled and brought to its final dimensions. In twin-belt casting, casting is followed by in-line hot rolling to produce a hot-rolled strip that is thinner than the strip produced in a twin-roll casting process. This means that the amount of cold rolling that is subsequently required is reduced. Our twin-belt continuous casting process also requires significantly less space than conventional processes. Up to 20 twin-roll casters are needed to produce as much as a single Hazelett caster does, meaning that Hazelett equipment has the lowest space requirements of any facility.

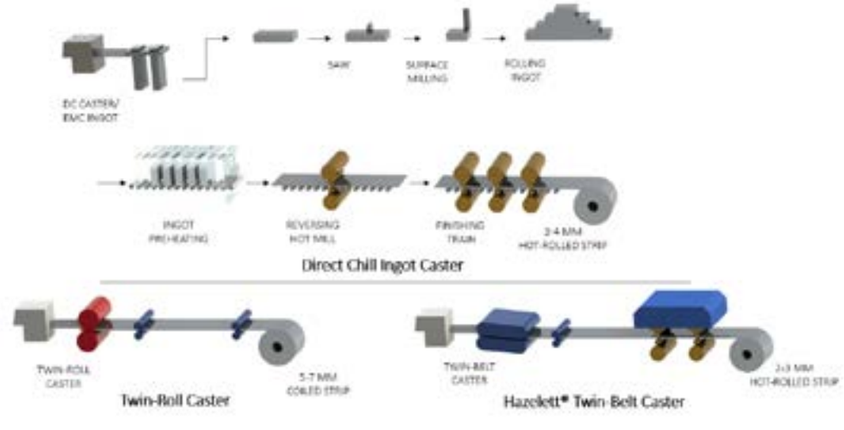
The image shown above shows a typical Hazelett line, which starts with a melting/holding furnace and continues with metal treatment, casting, in-line hot rolling and winding.

The majority of the Hazelett facilities built in North America during the 1980s and 90s were for scrap. The new millennium, however, saw both the rapid expansion of existing smelting plants and the construction of new ones, particularly in China. The focus thus shifted to Hazelett facilities that were built close to these plants and at which the molten metal could be transformed into sheet. Directly supplying a Hazelett line with metal from a potline is one of the most cost-efficient methods of adding value to molten metal.

However, as the construction of new melting facilities has slowed and awareness of the need to reduce energy consumption and ecological footprints has increased, there has been renewed interest in charging Hazelett lines with recycled scrap. Hazelett casting facilities are capable of producing a wider spectrum of alloys than twin-roll casters, making the Hazelett process particularly attractive for the recycling of post-consumer scrap.

Together with MINO SpA, the members of the **EBNER** GROUP (Gautschi / GNA and Hazelett) offer fully integrated facilities for the continuous casting of aluminum strip - regardless of whether the project is based on the use of primary metal or recycled scrap.

Process routes for the production of aluminum sheet



FAMETEC sets new standards.

The next generation of energy-efficient, high-tech solutions for sapphire single crystals.

STEPHAN PUXKANDL

Arctic Sapphire
Managing Director

Based on the research goals of EBNER Industrieofenbau GmbH, a unique furnace to grow sapphire single crystals was successfully developed early in 2012.

Today, **FAMETEC** is a member of the ADVANCED MATERIALS business unit of the **EBNER** GROUP. It is the sole European manufacturer of high quality monolithic sapphire products with diameters of 6 or 8", as well as a focus on 12" products.

FAMETEC's McSAP sapphire supplies the state-of-the-art technology required for optoelectronic products (LEDs, mini-LEDs, micro-LEDs), semiconductors and equipment used in the medical and optical industries.

The framework of the *European Chips Act*, which aims to increase the EU's share of global chip production from 10 % to 20 %, has only strengthened our vision of McSAP technology as the new standard for producing even larger and 100 % sustainably-grown sapphire substrate.

When used in applications such as micro-LEDs, power electronics and optical equipment, "green" McSAP sapphire is significantly more energy-efficient, of higher quality, and priced more competitively. **FAMETEC**'s advanced sapphire products enable manufacturers to increase yield and lower manufacturing costs, even they reduce their carbon footprints at the same time.

FAMETEC TECHNOLOGY

The crystal growth process employed by **FAMETEC** is based on newly-developed McSAP technology, which employs a simultaneous multi-crystal growing process. In this process, the sapphire crystal boules are grown along either the a-axis or c-axis.

Thanks to the over 75 years of experience we have in the design and manufacture of furnaces, a sturdy furnace design could be developed that maximizes the synergy between process development and furnace performance. Furthermore, the digitalization measures we have implemented along our entire supply chain allows our company to provide continuous transparency and traceability. Our use of top-notch QM systems ensures the success of products.

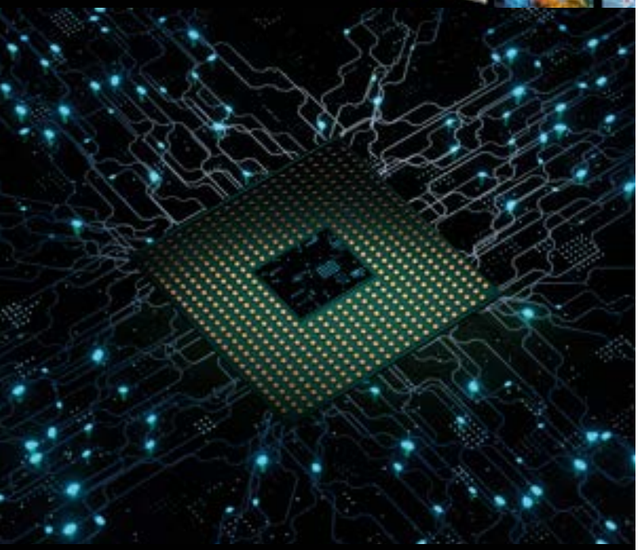
FAMETEC sapphire boule

FAMETEC PRODUCTS

In conventional methods used to produce monolithic silicon or sapphire crystals such as the Czochralski or Kyropoulos processes, a cylinder must be drilled out of a boule (raw crystal) at an angle of 90° to the direction of growth (i.e. along the a-axis). Wafers are then cut from this cylinder (the *ingot*) to create the *substrate* (surface that is used for the subsequent manufacture of chips).
In either one of these processes, roughly 60 % of the material is scrapped during downstream processing. This amount of production waste, combined with the high energy consumption of the melting process and the amount of manual handling that is required, not only decreases effectiveness and efficiency but also leads to an increase in emissions (e.g. carbon dioxide).

In contrast, the *Multi-C-axis Sapphire* (McSAP) process, a patented crystal growth technology developed by **FAMETEC**, greatly improves yields and performance. Furthermore, **FAMETEC** collects detailed data from each and every stage of the process, from raw material to finished product, to ensure and confirm the quality of the final product.

Boules and ingots produced using **FAMETEC**'s McSAP process are used in downstream production processes to produce high-quality sapphire substrates. These substrates are then used to manufacture high-performance micro-LEDs and power devices.



FAMETEC MARKETS/APPLICATIONS

LED/MICRO-LED DISPLAYS

Micro-LED technology is considered a game-changer for the display industry, due to its outstanding characteristics when compared to OLED and LED technologies. Using micro-LEDs, low power consumption plays a key role in energy savings even as superior pixel density, excellent contrast ratio and outstanding brightness allow crystal-clear images to be displayed. The number of potential applications defies imagination, ranging from high-definition TVs, image sensors, lamps and lights used in automobiles and aircraft, and commercial/entertainment displays to industrial textile applications.

Paired with **FAMETEC**'s energy-efficient McSAP production process, this leads to a drastic reduction in carbon emissions.

HIGH POWER ELECTRONICS

Sapphire is one of the most suitable substrates for high-bandgap semiconducting materials like GaN, SiC, and AlN. This due to two of the most prominent characteristics of sapphire substrate, its adaptability and accessibility.

Sapphire is not only stable when exposed to physical changes, but is also stable when subjected to a wide variety of chemical treatments.
Although extensive R&D effort is being expended on the study of Si substrates as an alternative, in terms of thermal expansion sapphire is still the best choice that can be made.

OPTICAL APPLICATIONS

Sapphire has always been used in optical applications, as it is not only highly durable but has excellent optical properties across a spectrum ranging from UV (ultraviolet) to IR (infrared).
Optical applications range from smartphone cameras and smart watches, which use sapphire as a cover glass, to large-scale uses in the aerospace and defense industries.

Thanks to the flexibility of its patented technology, **FAMETEC** is in a position to supply a wide range of materials. The versatility of **FAMETEC**'s McSAP furnaces and state-of-the-art inspection systems allow us to continuously optimize our sapphire growth process in response to market demands.

ORDERS ANNOUNCED OVER THE PAST 6 MONTHS.

REGION	FURNACE TYPE	MATERIALS	
SOUTH AMERICA	HICON/H_2® BELL ANNEALER FACILITY	Steel Wire	EBNER®
SOUTH AMERICA	HICON/H_2® BELL ANNEALER FACILITY	Copper Strip	EBNER®
NORTH AMERICA	HICON/H_2® BELL ANNEALER FACILITY	Steel Strip	EBNER®
CANADA	BATCH HOMOGENIZING FACILITY	Aluminum	GNA
CANADA	HOLDING FURNACE	Aluminum	GNA
USA	ROTARY FURNACE	Aluminum	GNA
USA	TILTING FURNACES FOR MELTING AND HOLDING	Aluminum	GNA
USA	PREHEATING FURNACES	Aluminum	Gautschi®
EUROPE	HICON/H_2® BELL ANNEALER FACILITY	Copper Strip	EBNER®
EUROPE	HICON® OVERHEAD FURNACE	Aluminum Coil	EBNER®
EUROPE	HICON® BATCH-TYPE FURNACE FACILITY	Aluminum Coil	EBNER®
EUROPE	CRYSTAL GROWTH FURNACE	Sapphire	EBNER®
EUROPE	TRAVELING PREHEAT FURNACE	Aluminum	GNA
ITALY	ROLLER-HEARTH FURNACE FOR SOLUBILIZATION OF COILS AND BARS	Steel Long Products	EBNER®
GERMANY	PIT-TYPE FURNACE FOR ROLLING INGOTS	Aluminum	Gautschi®
CH	PUSHER FURNACE	Aluminum	Gautschi®
ASIA	HICON® BATCH-TYPE FURNACE FACILITY	Aluminum Coil	EBNER®
ASIA	HICON® BATCH-TYPE FURNACE FACILITY	Aluminum Coil	EBNER®
ASIA	HICON/H_2® BELL ANNEALER FACILITY	Copper Strip	EBNER®
ASIA	HICON/H_2® BELL ANNEALER FACILITY	Steel Strip	EBNER®
ASIA	HICON® FLOATER-TYPE FURNACE	Aluminum Strip	EBNER®
ASIA	HICON® FLOATER-TYPE FURNACE	Aluminum Strip	EBNER®
ASIA	**HOTPHASE** ROLLER-HEARTH FURNACE FOR PRESS HARDENING	Steel Blanks	EBNER®
ASIA	HICON/H_2® BELL ANNEALER FACILITY	Steel Strip	EBNER®
CN	**HOTPHASE** ROLLER-HEARTH FURNACE FOR PRESS HARDENING	Steel Blanks	EBNER®
CN	HICON/H_2® BELL ANNEALER FACILITY	Steel Strip	EBNER®
CN	HICON® FLOATER-TYPE FURNACE	Aluminum Strip	EBNER®
CN	HICON/H_2® VERTICAL BRIGHT ANNEALING LINE	Copper Strip	EBNER®
CN	**HOTPHASE** ROLLER-HEARTH FURNACE FOR PRESS HARDENING	Steel Blanks	EBNER®
CN	**HOTPHASE** ROLLER-HEARTH FURNACE FOR PRESS HARDENING	Steel Blanks	EBNER®
TH	HICON/H_2/N_2® BELL ANNEALER FACILITY	Steel Wire	EBNER®
INDIA	ROUND TOP MELTING FURNACES	Aluminum	Gautschi®
AU	CRYSTAL GROWTH FURNACE	Sapphire	EBNER®

NEWS

HICON® Journal is also available by email!

Trade fairs. Conventions. 2023 & 2024

OCT. 25 - 26, 2023	**ALUMINUM USA**	Nashville	**USA**	Booth no.	**#101**
NOV. 14 - 17, 2023	**SEMICON EUROPA**	Munich	**DE**	Booth no.	**B0/302**
APRIL 15 - 19, 2024	**WIRE DÜSSELDORF**	Düsseldorf	**DE**	Booth no.	**TBA**
OCT. 8 - 10, 2024	**ALUMINIUM DÜSSELDORF**	Düsseldorf	**DE**	Booth no.	**TBA**

We look forward to seeing you there!

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