

Ceramic & Glass

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MANUFACTURING

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HOW IT'S DONE: CREATING A CULTURE OF QUALITY

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Mark Mecklenborg

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Eileen De Guire

Director of Technical Content and Communications
edeguire@ceramics.org

David Holthaus

Content Editor
dholthaus@ceramics.org

Lisa McDonald

Associate Managing Editor

Tess Speakman

Senior Graphic Designer

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Graphic Designer

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Production Editor

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Customer Service & Circulation

ph: 866-721-3322 fx: 240-396-5637
customerservice@ceramics.org

Advertising Sales

National Sales

Kevin Thompson, Industry Relations Director

kthompson@ceramics.org

ph: 614-794-5894

Editorial & Advertising Offices

The American Ceramic Society

550 Polaris Pkwy., Suite 510

Westerville, OH 43082

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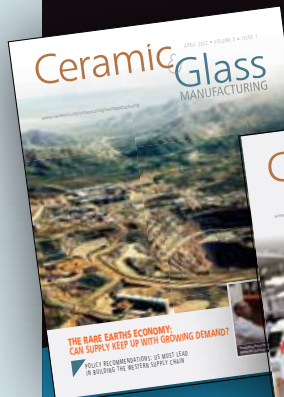
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CORRECTION:

In the June/July 2022 issue of *Ceramic & Glass Manufacturing*, the given founding place of HarbisonWalker International was incorrect. This error has been corrected in the archival version of the issue.

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INDUSTRY NEWS

The Bosch Advanced Ceramics engineering and manufacturing complex in Immenstadt, Germany.



BOSCH COLLABORATES ON ADDITIVELY MANUFACTURED MICROREACTOR

Bosch Advanced Ceramics collaborated with the Karlsruhe Institute of Technology and the chemical company BASF to develop a complex microreactor made of technical ceramics for high-temperature reactions. It was produced using additive manufacturing. Microreactors are used to research the fundamentals of chemical-technical processes, among other things, which requires them to withstand extreme temperatures. Bosch says the use of additive manufacturing enabled the design and construction of very small internal flow channels for the chemical reactions inside the reactor.



In the U.S., about one million people receive an artificial knee joint every year.

FDA MOVES FORWARD ON CERAMTEC KNEE REPLACEMENT

CeramTec says that the U.S. Food & Drug Administration confirmed that its ceramic total knee replacement device and proposed plan for use meet the criteria of a "breakthrough device." The goal of the FDA's Breakthrough Devices Program is to provide patients and health-care providers with access to new medical devices by speeding their development, assessment, and review. Hadi Saleh, CEO of CeramTec, says, "The ceramic knee is one of the lighthouse projects in our innovation pipeline." He says the company is working to introduce it to the U.S. market in a few years.

NANO DIMENSION ACQUIRES NETHERLANDS-BASED COMPANY

Nano Dimension Ltd., a supplier of ceramic additive manufacturing 3D printers, acquired Formatec Holding B.V., which includes its two subsidiaries, Admatec Europe B.V. and Formatec Technical Ceramics B.V. Based in the Netherlands, Admatec/Formatec comprises two complementary businesses operating together to develop and manufacture 3D printing systems for ceramic and metal end-user parts. Nano Dimension says it paid \$12.9 million for Admatec/Formatec. The business posted \$5.3 million in revenue, with a gross margin of 56%, in 2021.

SINTX ACQUIRES ADVANCED CERAMICS COMPANY

SINTX Technologies, Inc. acquired Technology Assessment and Transfer, Inc. SINTX says the acquisition will significantly increase its capabilities in the aerospace, defense, and biomedical markets. TA&T, based in Maryland, is a nearly 40-year-old advanced ceramics business that specializes in developing and commercializing materials for defense, biomedical, and industrial applications. The company's technologies and products include 3D printing of ceramic medical devices and heat exchangers, chemical vapor infiltration, and deposition of complex fiber-reinforced ceramic matrix composites.



Salt Lake City-based SINTX develops advanced ceramics for medical and nonmedical applications.



Admatec's Admaflex 130 3D printers.

AGREEMENT SIGNED TO EXPAND SEMICONDUCTOR MANUFACTURING

STMicroelectronics and GlobalFoundries Inc. signed a memorandum of understanding to create a jointly operated 300-mm semiconductor manufacturing facility adjacent to ST's existing 300-mm facility in Crolles, France. The facility is targeted to operate at full capacity by 2026, with up to 620,000 300-mm wafer per year production. ST and GF say they will receive significant financial support from France for the new facility, which will contribute to the objectives of the European Chips Act, including the goal of Europe reaching 20% of worldwide semiconductor production by 2030.



STMicroelectronics' semiconductor manufacturing plant.



Dalmia Bharat Refractories provides refractory materials and services in more than 40 countries.

REFRATORIES SUPPLIERS REACH LICENSE AGREEMENT

Shinagawa Refractories entered into a know-how license agreement with Dalmia Bharat Refractories of India. Shinagawa aims to expand its footprint in India, and it says the agreement serves as the first step toward future development. Shinagawa, headquartered in Tokyo, is one of the largest refractory suppliers in the world. Dalmia Bharat provides refractory materials and services to clients in more than 40 countries, and operates seven manufacturing sites: five in India, one in China, and one in Germany.

ŞİŞECAM INVESTS IN FURNACE FOR ENERGY GLASS

Şişecam plans to invest in a patterned glass furnace with a capacity of 600 tons per day and energy glass processing lines with a capacity of 20 million square meters per year at its facility in Mersin, Turkey. Şişecam currently operates eight flat-glass lines and one patterned-glass line at four locations in Turkey. With the latest investment, Şişecam says it aims to be one of the main suppliers in the renewable energy sector globally. Once it reaches full capacity, the new furnace is expected to generate annual sales revenue of 120 million euros.



Şişecam operates 45 facilities in 14 countries.

STOELZLE INVESTS IN FURNACE EXPANSION

Stoelzle Częstochowa rebuilt and expanded its flint furnace so it can now reach a production capacity of 480 tons per day thanks to three more efficient and faster production lines. The total investment amounts to 45 million euros and increases the efficiency of the melting output by 45%. With the investment at the Polish site, the company says it reached a milestone in its long-term growth strategy. It opened a logistics center in 2021 and installed a high-speed spraying line in March 2022.



The Stoelzle team and guests inside the new furnace.

HOW IT'S DONE: CREATING A CULTURE OF QUALITY

By David Holthaus

Quality is more than a buzzword; in the manufacturing world, it is an essential practice.

As long ago as 1930, a vice president of a milk manufacturer described the practice of quality in a now oft-quoted speech: "Quality is never an accident. It is always the result of high intention, sincere effort, intelligent direction, and skillful execution."

Quality improves productivity, enhances worker safety, saves money, and creates loyal customers. Attaining high quality consistently is a never-ending process of continuous analysis and improvement.

To get at the recipe for a culture of quality, we interviewed executives at two refractory manufacturers, Saint-Gobain and Allied Mineral Products. Their products must withstand extreme temperatures and corrosive environments—meaning quality is of utmost importance.

SAINT-GOBAIN

Saint-Gobain is a 350-year-old Paris-based multinational corporation that attained an international reputation for quality. Its SEFPro division provides refractory solutions to the glass industry, which it has done for the past 85 years.

Andrea Kazmierczak has worked for Saint-Gobain for more than 18 years and is currently R&D process leader with the SEFPro unit at its Northborough, Mass., location. She spoke to us about the company's quality processes.

Q: What is your role in improving and protecting quality?

A: It's twofold. At Saint-Gobain, one of the major functions of R&D is to have strong relationships with our customers. We learn about



The Saint-Gobain Group is a \$44 billion company with 166,000 employees. Credit: Saint-Gobain

ways to help provide value to them, by improving the quality or guaranteeing the quality of materials. We support the customer at every step of their project through the various services we provide. We help our customers identify defects in their glass, so they can rely on us to quickly and efficiently analyze the problem and provide them with the information to correct it. We work very closely with our global fleet of manufacturing plants in pursuing new technologies and implementing processes to ensure that our facilities are providing the best quality of materials to our customers.

Q: Can you drill down on some specifics and best practices that your company follows?

A: Something that stuck with me early on as a process engineer and then a quality manager is just the cost of quality, investing in quality testing. You have employees, technicians, and engineers involved to analyze the data. That cost is not negligible. But it has been instilled in me how much that can affect the quality of the products going forward. Catching a problem early on will save a tremendous amount of money. Looking at things like qualifying and ensuring good quality raw materials is a good example of that. If you cannot certify that your raw materials are stable, that they are within a set specification, you could have a ticking time bomb and you will not know it until you have a load of scrap materials. Investing that time early on is critical.



Andrea Kazmierczak

Q: How do you work to catch problems early?

A: Quality is everyone's job. It is important to instill that in everybody. Operators and technicians are empowered to speak up if they see something different, or an incoming shipment comes in a different color bag, or if you have something that just does not look the same. Everybody's empowered to speak up and bring attention to these things.

Q: How do you create that culture, that attitude among employees?

A: That is everybody's bottom line. We are all trying to reach the same goal, to support our customers in every aspect of their project. We want to understand our customer's needs and deliver what they want, on time, all the time. It is instilled in process engineers the first day you come in. We place a big emphasis on traceability, so we can relate the materials and process to quality. During a customer furnace tear-down, we can often go back to the drawing or a parts list and trace the history of each part manufactured from the raw material to when it left out dock.

Q: Is there a continuous improvement process that you follow?

A: Yes, that's involved with the ISO 9000 system, and there is a strong emphasis on continuous improvement and getting to the root cause of a problem. If there is an issue, we log it, and either talk in a small group or a large group to hash out the corrective action, continuous improvements and the preventive maintenance or preventive actions that make sure we do not have a repeat occurrence or similar one in another area. It is really for the customer to have complete confidence about the quality of the materials they purchase.

Q: Is their employee training along those lines?

A: Everyone coming in learns about quality. There is information about the cost of quality, and process engineers go through a

SMART program where they get a handle on every aspect of the plant. They are put into an operator's shoes in different departments.

Q: When you visit a plant, what do you look for?

A: A lot of my projects are in the later stages of getting out to a customer, so I'm helping to make sure that the properties we attained in a lab are maintained throughout the scaleup of the process. Sometimes when you are in the fire at the manufacturing plants, it is hard to see the long-term or systemic problems that can happen.

Q: How do you work with your suppliers to ensure quality?

A: We have lists of critical suppliers and we do audits on them. There are different categories, different tiers of suppliers. Critical or sole source suppliers, for instance, would be more closely scrutinized. We make sure we have secondary sources for raw materials. If we do make a change, it is not done lightly. We go through extensive quality control checks whenever we make a change to the batch or process, no matter how minor it is. We make sure everything's still as expected. There is a follow-up required for each of those changes.

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Allied Mineral Products: Where quality begins at the top

Founded in 1961, Allied Mineral Products has grown into a global company and leading producer of monolithic refractory products for a wide range of industries. Based in Columbus, Ohio, the company operates 12 manufacturing facilities in eight countries, and sells its products in 100 countries.

At Allied, quality begins at the top, says Doug Doza. Doza is an executive vice president who has worked at Allied for more than 37 years. "It's the corporate culture," he says. "It's driven by leadership."

Allied has built a reputation for quality through a sustained focus on its customers, who range from steelmakers to aluminum producers to heat treating operations.

"Our quality system is really about customer focus," Doza says. "How do you characterize and measure our products and our raw materials throughout our process so that the products we produce are fit for use in the eyes of the customer."

Sounds almost simple, but maintaining reproducibility and consistency with products that must withstand extreme temperatures, molten metal, and other thermal shock conditions is an ongoing process that involves continuous improvement and measurement, as well as communication with customers.

That necessarily involves engaging the company's employees in quality assurance and making its practice a part of everyone's role on a daily basis, Doza says.

"Employees need to be actively involved and understand the product and the products' features so that they can develop appropriate inspection plans," he says.

Allied employs teams of engineers who work with customers to help determine what their needs are. They work to understand the customers' processes and goals and what the products' performance requirements will be. They then engineer solutions by selecting products from Allied's extensive list or creating advanced ceramic customized solutions that make the best use of an existing product or creating a new one.



Some of the employee owners of Allied. Credit: Allied Mineral Products



Doug Doza

"If you do not understand the customer's needs, you cannot design or manufacture a product that is optimized for their process," Doza says.

Training and communication within the organization, as well as outside the organization, by the Allied team and with its customers is ongoing.

Befitting a company in the business of precision manufacturing, Allied measures employee engagement on a regular basis. The company annually asks employees to complete a Gallup-style survey that ascertains how they feel about their jobs and other workplace issues.

"There are metrics that go with employee engagement," Doza says. "You need to have measurements and rate yourself to those measurements."

At Allied, employees tend to be inherently interested in the company's performance because they are owners of the company through an employee stock ownership plan. "Employee engagement is part of our calling," Doza says.

Part of the company's ongoing training and employee communication plan is promoting awareness of shared goals so employees can optimize their work to benefit the company and themselves.

Allied also holds employee round tables regularly where employees can hear about new projects and have opportunities to meet with senior leadership. It is a practice Allied has been doing for about 25 years, Doza says.

"Twice a year we sit down and they ask us questions until they're out of questions," he says. "The executive team wants to know—how can we get better and how can Allied get better? What's happening that we're not aware of?"

Allied's efforts ultimately come down to this continuous improvement practice, Doza says. "What decisions do we make today to make us better tomorrow?"



The Jon K. Tabor Global Business Center at Allied Mineral Products. Tabor, former chairman and CEO of Allied, who recently passed away, was an inspiration behind Allied's quality culture. Credit: Allied Mineral Products

Q: St. Gobain is such a large company, with so many different sectors and so many manufacturing plants. Are there practices you could spotlight that help the company ensure it has a culture of quality across all divisions?

A: We look at what the core values are for the customer, and the quality really comes from the commitment to the customer. We are committed to providing them with a product that meets their needs. We get an understanding of what the customer wants, and once you meet with a customer, you start to become invested in their success.

Q: Are there any new trends or new practices that you have implemented or you are seeing in the industry?

A: There is a lot of potential for using sensors and nondestructive testing techniques to help our customers monitor their furnaces better. We have a complete suite of services where we can help monitor gas emissions to help them get a longer life out of their furnace or maybe diagnose issues or improve efficiencies and detect if there are any temperature leaks. The current trends are leading us to help customers get more and more lifetime out of their furnaces, and help them adapt to environmental regulations. ▽



SEFPro is dedicated to offering refractory solutions to the glass industries. Employees work to ensure that properties attained in a lab are maintained throughout the scaleup of the process. Credit: Saint-Gobain



Northborough, Mass., is Saint-Gobain's largest research center. Credit: Saint-Gobain

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DEFLECTION ELBOWS PREVENT BLOWOUTS, PRESERVE PURITY OF CERAMICS AT COORSTEK

By Charles Williston

CoorsTek is a world leader in technical ceramics, or materials that are highly resistant to mechanical, chemical, electrical, and thermal degradation. Applications span numerous industries, including aerospace and defense, chemicals, electronics, energy, and medical.

In 2019, CoorsTek opened its Center for Advanced Materials (CCAM) in Golden, Colo. It combines a research and development hub, an analytical laboratory, and a materials manufacturing facility. CCAM's mission is to accelerate production of commercial ceramics using the latest technologies.

Its manufacturing side is dedicated to handling alumina (Al_2O_3), which rates 9 on the Mohs hardness scale, just below diamond.

"It's extremely abrasive," says Andrew Harm, CoorsTek process engineer, who led the commissioning of CCAM's eight pneumatic conveying systems.

These dilute-phase lines were built to transport the alumina between operations, from railcar unloading to mixing, milling, spray drying, and storage. The conveying systems' elbows were unfortunately no match for the abrasive alumina.

"I don't think it was communicated clearly how abrasive our materials are," Harm says. "They very quickly started poking holes in the elbows."



CoorsTek installed Smart Elbow deflection elbows after experiencing failures of ceramic-lined sweep elbows along its eight pneumatic lines conveying highly abrasive alumina. Credit: HammerTek

In some cases, the elbows failed after handling only 20,000 to 30,000 lbs (9,100 to 13,600 kg) of alumina. "Our batch size is 100,000 lbs (45,400 kg), so it was a substantial issue for us," Harm says.

In addition to downtime, premature wear caused product contamination with as much as 150 ppm of magnetic iron emanating from pipe-line and elbow wear. "We care about iron in our material, especially our materials that go to the semiconductor industry and for defense," Harm says. "The chemistry and purity are extremely important."

PREVENTING ABRASIVE ALUMINA FROM IMPACTING THE ELBOW WALL

The ceramic linings of the original elbows had a Mohs hardness of just 5 to 6. As those wore through, Harm and his staff experimented with other types of elbows. The most effective proved to be Smart Elbow deflection elbows from HammerTek Corp.

These specialty bends have a spherical vortex chamber protruding from the inlet leg. As material enters the bend, a portion of the flow is diverted automatically into the vortex chamber, where it forms a loosely packed mass that slowly rotates in the direction of flow. This mass gently deflects incoming particles around the bend. Because some material continuously filters out of the chamber as new material enters, the rotating ball of material is continuously replenished. In addition, the material exits evenly across the outflow of the elbow without skidding along the outside radius as occurs with sweep elbows.

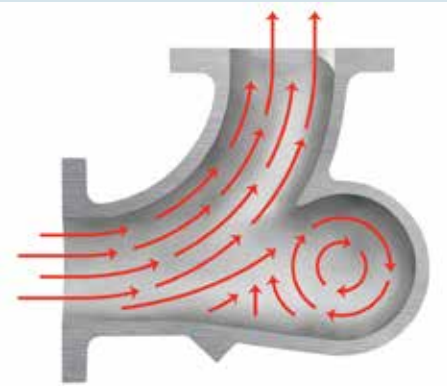
Although the deflection elbows are more expensive initially than other styles Harm tried, such as blind tees, they reduced costs and improved quality. "We get very little wear from the deflection elbows, so we're not wearing off that metal into our product. That by itself is enough for us to justify the cost," he says.

Eliminating the blowouts, the mess, and unscheduled downtime was a bonus. "We can make the case from a purely manufacturing standpoint, too," Harm adds.

REPLACING SWEEP ELBOWS PROACTIVELY

CoorsTek initially installed the deflection elbows in phases after it commissioned each conveying system and the original sweeps wore out.

"We did that with a couple of systems, but by the time we started running the fifth or sixth system, we went whole hog," Harm says.



A spherical vortex chamber protruding from the deflection elbow causes a loose ball of ceramic material to rotate in the same direction as the airstream that powers it, deflecting particles around the bend without impacting or wearing the elbow wall. *Credit: HammerTek*



CoorsTek replaced most of its double-wall sweep elbows (foreground) with Smart Elbow deflection elbows (rear). *Credit: HammerTek*

"Waiting [for a blowout] was causing too much unplanned downtime. If you already have the part on hand and plan for it, changeout time is minimal, maybe half an hour."

Replacing difficult-to-access elbows, however, takes more time and planning. The most difficult were the elbows atop CCAM's 90-foot-tall (27.4 m) outdoor silos. It took two days and required hiring a crane and building special scaffolding, but there was no alternative, Harm says. "We can't be blowing our material out to the open," he affirms.

The silo elbows were the last of the 65 Smart Elbow bends that CoorsTek installed. Some of the bends are cast iron, but most are made from HammerTek's HammerLoy, a more abrasion-resistant material.

REDUCING PRESSURE DROP BY ONE-HALF TO ONE-THIRD

In addition to preventing contamination and blowouts, the deflection elbows reduced pressure drop. "With the blind tee elbows, we get 0.2 to 0.3 psi (1.38 to 2.1 kPa) pressure drop across the elbow itself. With the HammerTek elbows, we get about 0.1 psi (0.69 kPa) drop," Harm says. "That's a pretty significant difference. If we used four or five of those other elbows, it could mean a 20 percent pressure drop just across the elbows. It could drop the rate enough that we couldn't send material through."

Throughputs among the eight systems range from 4,000 to 20,000 lbs (1,800 to 9,000 kg) per hour. Conveying line runs are 80 to 300 ft (24.4 to 91.4 m) and pipeline diameters are 4, 5, or 6 in. (100, 125, or 150 mm). At the discharge end, material velocities can exceed 100 mph (161 km/h).

The oldest of the HammerTek elbows, installed two years ago, continues to perform. In noncritical areas, CoorsTek still has some blind tees and sweeps with double-wall construction.

"If we can get away without replacing them, great," Harm says. "But the first time one of those fails, we'll go ahead and swap those out as well." ▀

ABOUT THE AUTHOR

Charles Williston is national sales manager for HammerTek Corporation in Bethlehem, Pa. Contact Williston at sales@hammertek.com.



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SELEE Corporation
Semiconductor Energy Laboratory Co, Ltd (SEL)
Shandong Shengquan New Materials Co, Ltd
SHOEI CHEMICAL INC
Showa Denko America, Inc
Sigma Advanced Materials
Silicon Carbide Products, Inc
SINTX Technologies
Special Shapes Refractory Company
SPT Roth Ltd
Sunrock Ceramics Company
Surmet Corporation
Swindell Dressler International Company
SynThera Biomedical Private Limited
TevTech, LLC
Thermcraft Inc
Thermo Fisher Scientific
TOTO Ltd
US Borax
Vanderbilt Minerals, LLC
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XJet
Zircar Zirconia Inc
Zircoa, Inc

Interested in Corporate Partnership?

Contact **Kevin Thompson** at kthompson@ceramics.org or 614-794-5894 to learn more.



Alfred University
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CENTER FOR PROTOTYPE MANUFACTURING

The Alfred University Center for Prototype Manufacturing, located one mile off the Alfred campus, serves as an industrial pilot plant and user facility helping companies scale up lab developed processes to commercialization.

The Center maintains a Class 10,000 cleanroom housing a suite of KEKO multilayer ceramic processing equipment including casting, cutting, drying, stacking, and screen printing.

The center also provides users with access to:

- Various Mixing & Milling Processes
- Spray Drying
- Pressing (up to 80 ton)
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- High Temperature Processing (to 1800oC)
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