SAINT-GOBAIN PERFORMANCE CERAMICS & REFRACTORIES

BLAST FURNACE

REFRACTORIES FOR INCREASED SERVICE LIFE

SAINT-GOBAIN

SOLUTIONS TO EXTEND
BLAST FURNACE LIFE-TIME

IRON MAKING

GENERAL AREAS SERVED

Crude steel production begins with the reduction process, whereby iron ore reacts with carbon sources inside the blast furnace. It is imperative that refractory products used inside the blast furnace are resistant to these thermomechanical and thermochemical reactions.
Saint-Gobain Performance Ceramics & Refractories designs, engineers and supplies a comprehensive range of high quality refractory products and solutions, specifically developed for blast furnaces.

CO_2 SAFE ENERGY, REDUCE CO_2 EMMISSION

'INSULATE' YOUR BLAST FURNACE HEARTH

With its insulating effect compared to a pure carbon hearth the Ceramic Cup **reduces the coke consumption and the CO_2 emission** at the same time. With the CO_2 certificate trading already existing in Europe - for other regions/ countries to come - and with coke prices increasing the money saving effect will become a more and more important factor.

We provide ceramic materials designed to meet your needs:

QUALITY

EFFICIENCY

CUSTOM DESIGN

BENEFIT FROM OUR SERVICES

DESIGN & ENGINEERING

CUSTOMIZED SOLUTIONS

We measure our success with your operating results. To enhance your performance, our team of passionate top skilled engineers are ready to develop the best adapted solutions for your needs.
Our engineers tackle your design challenges with forefront equipment at your service with great experience/knowledge.

- Full BF design including Carbon
- Thermal Calculations using Ansys
- Repairs
- Large Block Size Capability

R&D FOCUS

AMONG TOP 100 GLOBAL INNOVATORS

R&D is part of the DNA of the Group, ranked as one of the top 100 innovators in the world. For our ceramics and refractory activity, we invest strategically in innovation to bring you the most efficient solutions developed at Saint-Gobain Research Provence, our center for R&D in Europe with a specialized team dedicated to Blast Furnace application.

QUALITY SUPPLY

International and global network of divisions and suppliers allow us to access the best quality inputs for our materials. Innovation focuses on material properties to supply solutions specifically adapted to Blast furnace application.

- Top Quality Grades
- Wide Range of Grades

EXPERTISE

MORE THAN 50 YEARS OF EXPERIENCE

Rich experience constitutes our total design capability that is unique and unsurpassed, thanks also to the knowledge gained via companies such as Savoie Refractories and Carborundum.

INSTALLATION

More than 350 references that have built our market recognition

- Supervision
- Technical assistance

INCREASED LIFETIME

IMPROVE YOUR BLAST FURNACE LINING

Supplying all required refractory products specifically developed to extend BF lifetime. Unparalleled experience in BF design supply for over 50 years and **several hundred references**, relying on global production capacity with factories positioned worldwide to serve all areas.

Our production facilities are certified by:

- Quality — **DIN EN ISO 9001**
- Environment — **DIN EN ISO 14001**
- Occupational Safety — **OHSAS 18001**

IMPROVE SERVICE LIFE OF YOUR BLAST FURNACE

FULL SUPPLY

Saint-Gobain Performance Ceramics & Refractories has over 50 years of experience in blast furnace refractory design. The company continually develops new and improved materials, adapting to industry trends and evolving customer requirements.

UPPER STACK

In this low temperature area, abrasion by the solid burden is the primary mode of wear. Our silicon carbide has proven to be cost-effective solution.

Refrax® 20 SBF / Alfrax® 85 MS2 A / Mullfrax® 60 MS6

LOWER STACK

Abrasion by the coke burden is still a concern but driven by an increasing temperature, in depth attack by Alkali and Zinc vapor become predominant. Our **Refrax® 20 SBF** is a worldwide recognized reference for this application.

Refrax® 20 SBF / Sicanit AL3 / Alfrax® 85 MS2 A

BOSH & BELLY

In addition to Alkali and Zinc attack, the occurrence of molten iron and slag calls for SiAlON bonded materials. We recommended either our silicon carbide **Sicanit AL3** or our Corundum based **Coranit® 3S**. The final decision dependes on thermal conductivity requirement (low, to save energy, or high, to promote a protective skull).

Sicanit AL3 / Coranit® 3S / Refrax® 20 SBF

TUYERE BELT

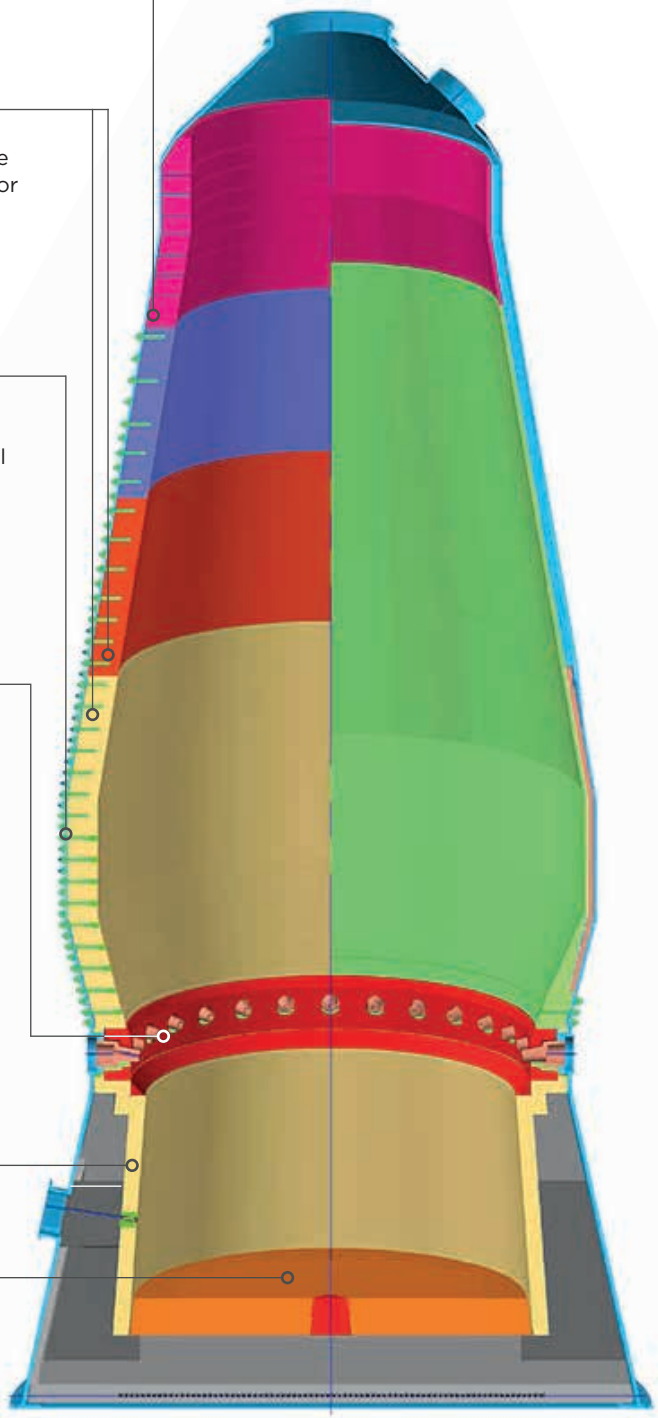
The tuyere sourrundings experience high heat load and thermal shock in combination with corrosion by molten iron and slag and intense Alkali and Zinc vapor attacks. Backed by a unique range of refractory materials, including silicon nitride or SiAlON bonded shapes and pre-formed no and low cement castables, our engineered tuyere sourrounings will fit best to the specific requirements of your Blast Furnace operation.

MonoCoral / MonoGuard / Sicanit TB

HEARTH

Traditionally, blast furnace hearths are lined with high thermal conductive carbon-based materials. Placed inside the carbon lining the concept of the **Saint-Gobain Ceramic Cup** is an example where a specific advanced design and material quality render significant benefit to blast furnace operators in terms of lifetime extension and operational efficiency. Beware of cheap copies on the Ceramic Cup. **Design** (avoiding high stress, and items floating off) **Material Quality** (to ensure slow wear) and correct **Installation** all need to be correct to ensure good lifetime.

Coranit® SlagR / Coranit® AL / Mullfrax® 70 MS4-F / Mullfrax® 70 ME



OUR PHILOSOPHY - ENHANCING PERFOMANCE

Saint-Gobain has pioneered and promoted "Ceramic Cup" technology since 1982. We have learned a lot over last four decades. We are now into our t**hird generation of design** (SiAlON bonded corundum – "Coranit®") and have recently developed a new improved quality called **Coranit® SlagR**. Detailed feedback from users has shown that the "Coranit®" grade wears very gradually over the lifetime of the hearth. **400 mm thickness** has been shown to last **9 years** or more. After the Ceramic Cup has worn, the carbon then wears quite rapidly until an equilibrium is reached whereby the hot face is sufficiently cooled to allow a **self-protecting "skull"** to form.

Operators are then able to maintain a stable "skull" to **achieve required campaign lifetime**. It has been observed on many occasions however that when the protective "skull" is lost the carbon can be worn away very rapidly resulting in dangerous situations. The **Ceramic Cup** does not depend on a "skull" to achieve its intended lifetime.

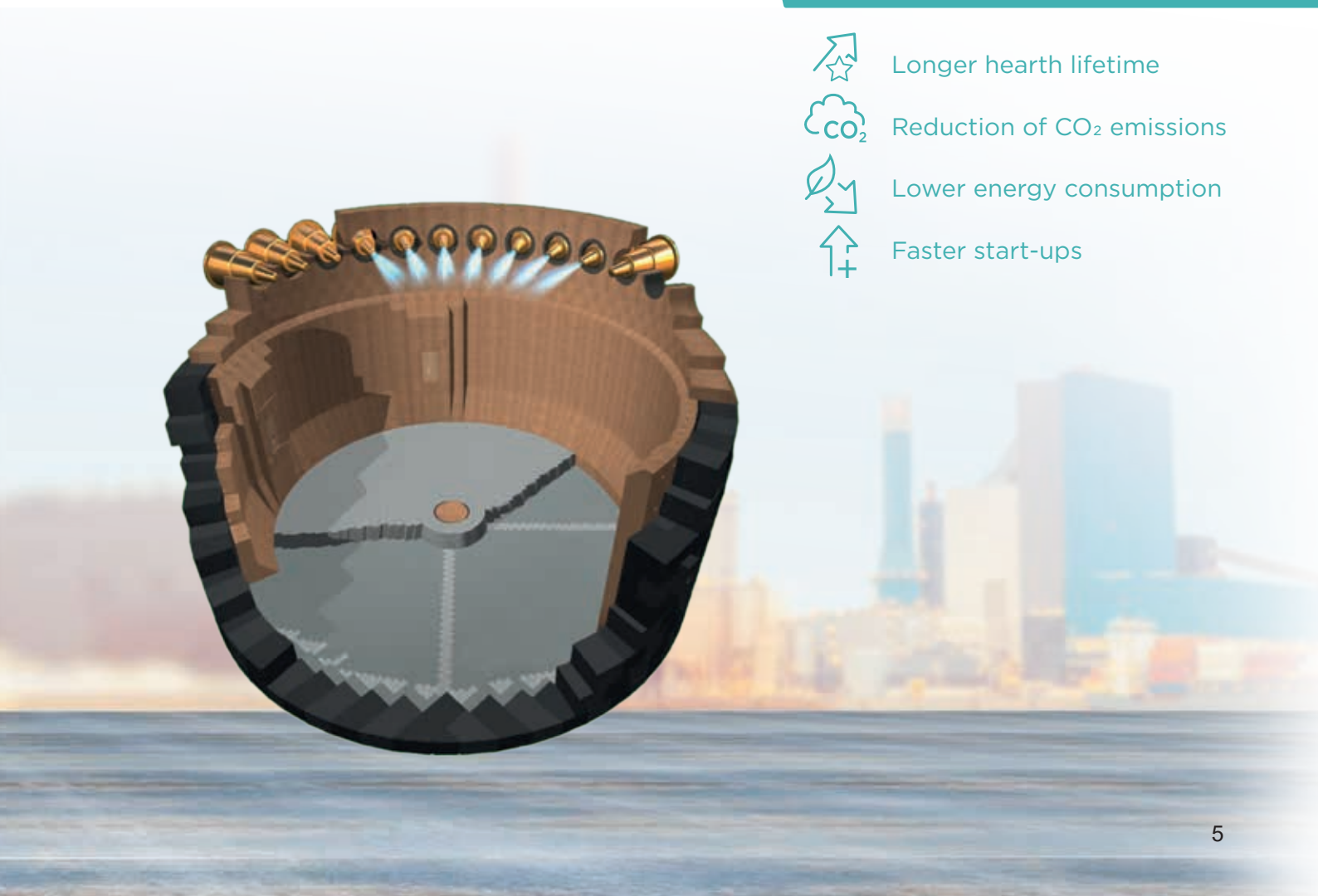
We can design your Blast Furnace Hearth using the following PHILOSOPHY:

Hot-Face of Ceramic Cup, with just enough thickness of carbon behind to allow a protective "skull" to build-up. No point in having too thick carbon as it will quickly wear to the equilibrium point.

In a perfect world the operator is able to achieve an eternal hearth lifetime by maintaining forever the protective "skull." In this case, there is no need for Ceramic Cup. Unfortunately, we do not live in a "perfect world". Operators get the benefit of maybe 10 years lifetime on the Ceramic Cup before needing to stabilise the "skull" (and avoid water leakages, variable raw materials, unplanned stoppages, large-dense dead-man formation, productivity variations etc.). It is this assurance that operators are given when adopting **SG Ceramic Cup technology**."

BENEFITS

- Longer hearth lifetime
- Reduction of CO_2 emissions
- Lower energy consumption
- Faster start-ups

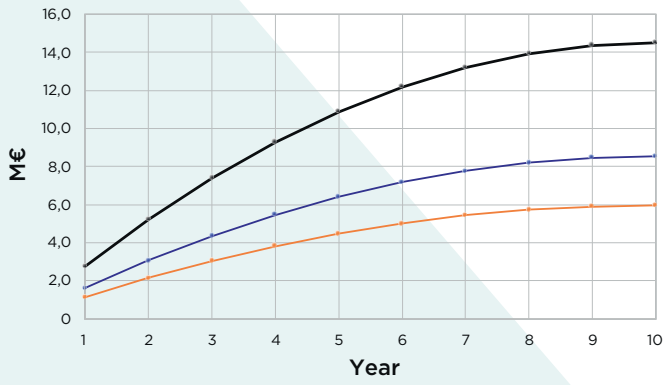


UP TO
59%
ENERGY SAVINGS*

CERAMIC CUP SOLUTION

Designed to boost the performance of Blast Furnace, withstanding the severe conditions inside Blast Furnace hearth. Applicable also in other parts of BF that face extreme conditions. Heat flow from the hearth wall/bottom are in the ratio of approximately 80:20.
With a Ceramic Cup wall the thermal conductivity of the Coranit® is around 3.5 W/mK at 1000°C whereas many super-micropore carbons are over 20 W/mK. Heat flow at hearth wall drops from around 15 W/m² with carbon to 5 W/m² with a Coranit® Ceramic Cup. It is clear that heat flow reduction is good for the environment, good for economy!

Ceramic Cup Savings (M€) after "x" years:



TOTAL COKE SAVINGS	20 kt
TOTAL CO_2 SAVINGS	65 kt

Graph:
Case study calculated on an existing blast furnace wih ceramic cup (hearth diameter 11m)
*in hearth with Saint-Gobain Ceramic Cup

CERAMIC CUP WALL

Pioneering this solution since 1982, Saint-Gobain recently developed a 3rd generation of Coranit® Ceramic Cup quality with enhanced the characteristics.

SIALON BONDED CORUNDUM BRICK

Coranit® SlagR

- Improved mechanical stability
- Better slag/iron resistance
- Excellent abrasion resistance

Coranit® AL

- Iron / slag corrosion resistant
- Good abrasion resistance
- Alkali corrosion resistance

CERAMIC CUP PAD

Best solutions to protect the bottom of the Blast Furnace, with materials that are highly resistant to Iron.

HIGH ALUMINA BRICK

Mullfrax® 70 MS4-F / Mullfrax® 70 ME

Both Mullfrax® 70 MS4 and Mullfrax® 70 are well suited for hearth pad application. Both can be provided in circular and herring bone design.

TUYERE BELT SOLUTION

Big block tailor-made that can be customized according to your needs. There is no universal quality that has been accepted as recognized solution for tuyere belt, carbonaceous materials as well as SiC or Al_2O_3 are used but we suggest our **three top performing materials**. Each operator can decide the best solution depending on what he considers to be the main wear mechanism for his Blast Furnace (refractoriness, slag/iron attack, oxidation attack, alkali attack, abrasion etc.).

MonoCoral

- The original Ultra-Low Cement **Corundum**
- Big Block with 89% alumina
- Almost 100 references for tuyere and counting

MonoGuard

- Improved Corundum Big Block
- Increased Iron and slag resistance
- High strength and stability

Sicanit TB

- Pre-assembled sialon bonded SiC bricks
- Combines the properties of SiAlON bonded bricks with same easy and fast installation as for a pre-cast block

BOSH

As for Bosh application, Sicanit AL3 (SiAlON bonded SiC) with improved alkali and oxidation resistance or Coranit® 3S (sialon bonded corundum) are most often chosen, the latter when low thermal conductivity is required.

Refrax® 20 SBF or Alfrax® 85 MS2 A can also be chosen for lower stack. In addition to alkali and zinc attack, the occurrence of molten iron and slag calls for:

Silicon Carbide	**Corundum**	**Silicon Carbide**
SiAlON / Nitride bonded	SiAlON bonded	Nitride bonded
Sicanit AL3	**Coranit® 3S**	**Refrax® 20 SBF**

CERAMIC CUP

More than 102 references for Ceramic Cup:

Year	CUSTOMER	LOCATION	COUNTRY	BF-N.	HEARTH DIA (M)	BOTTOM	CERAMIC CUP
2022	DK Recycling	Duisburg	Germany	3	5,5	**Coranit® SlagR**	**Coranit® SlagR**
2022	Salzgitter	Salzgitter	Germany	A	11,2	-	**Coranit® SlagR / Coranit® AL**
2021	POSCO	Pohang	South Korea	4	14,96	-	**Coranit® SlagR**
2020	ArcelorMittal Juiz de Fora	Juiz de Fora	Brazil	1 & 2	4,3	**Alfrax® 75 TCN**	**Coranit®**
2019	Isdemir	Iskenderun	Turkey	1	12,5	-	**Coranit® SlagR**
2019	Erdemir	Eregli	Turkey	2	10,0	-	**Coranit® SlagR**
2019	Baosteel	Baoshan	China	2	14,2	-	**Coranit® SlagR**
2019	NLMK	Lipetsk	Russia	4	10,3	-	**Coranit® AL**
2019	TISCO Taiyuan	Taiyuan	China	5	14,1	-	**Coranit® AL**
2018	Thyssen Krupp Stahl	Schwelgern	Germany	1	13,6	-	**Coranit® SlagR**
2017	Voest Alpine Stahl	Linz	Austria	A	12	**MS4**	**Coranit® AL**
2016	ArcelorMittal	Bremen	Germany	2	12	**MS4**	**Coranit® AL**
2016	NLMK	Lipetsk	Russia	6	12,3	-	**Coranit® AL**
2016	ArcelorMittal	Eisenhüt-tenst.	Germany	5A	9,75	**MS4**	**Coranit® AL**
2015	Tata Corus Ijmuiden	Ijmuiden	Netherland	7	13,8	**MS4, MS10**	**Coranit® AL**
2013	Jindal Steel Power Ltd	Raigarh	India	1	6,5	**MS4R**	**MonoCoral**
2013	Dillingen Rogesa	Dillingen	Germany	4	11,2	**48% Al_2O_3**	**Coranit® AL**
2012	HKM	Huckingen	Germany	B	11	**MS4**	**Coranit® AL**
2011	Bhilai steel	Bhilai	India	8	13,4	**MS4R**	**Coranit® AL**
2011	Hyundai	Danjin	South Korea	3	14,8	**70%Al_2O_3 48%Al_2O_3**	**Coranit® AL**
2011	ThyssenKrupp Stahl	Schwelgern	Germany	2	14,9	**48%Al_2O_3**	**Coranit® AL**

TUYERE BELT

138 references since 1986:

Year	CUSTOMER	LOCATION	COUNTRY	BF-N.	HEARTH DIA (M)	TUYERES
2021	Voest Alpine Stahl	Linz	Austria	5	8,0	**MonoGUARD**
2020	ArcelorMittal Tubarão	Serra	Brazil	3	12,5	**Refrax® 20 SBF (bricks)**
2020	ArcelorMittal Juiz de Fora	Juiz de Fora	Brazil	1 & 2	4,3	**MonoCORAL**
2020	HKM Mannesmann	Huckingen	Germany	B	11,0	**MonoCORAL, inserts Coranit® 3S below Coranit® 3S**
2019	DK Recycling	Duisburg	Germany	3	5,5	**MonoCORAL & MonoGUARD**
2019	ArcelorMittal Gent	Gent	Belgium	B	10,9	**Upper Graphite RFH Lower MonoGUARD**
2019	CSN	Volta Redonda	Brazil	3	13,5	**Refrax® 20 SBF (bricks)**
2018	Thyssen Krupp Stahl	Schwelgern	Germany	1	13,6	**MonoCoral**
2017	ArcelorMittal	Bremen	Germany	2	12	**Sicanit TM Sicanit AL3**
2017	DK Recycling	Duisburg	Germany	3	5,5	**Sicanit TM**
2016	EKO Stahl	Eisenhüttenst.	Germany	5A	9,75	**MonoGuard**
2016	Voest Alpine Stahl	Linz	Austria	6	8	**MonoGuard**
2014	Voest Alpine Stahl	Linz	Austria	5	8	**MonoGuard**
2014	JSW Dolvi	Dolvi	India	1	13,8	**MonoCoral**
2014	SG PAM	Pont à Mous-son	France	3	5,68	**MonoCoral**
2014	Voest Alpine Stahl	Linz	Austria	A	12	**MonoGuard**
2013	ArcelorMittal	Newcastle	S.Africa	5	10,14	**MonoCoral**
2013	Voest Alpine Do-nawitz	Donawitz	Austria	1	8	**MonoCoral**
2013	Jindal Steel Power Ltd	Raigarh	India	1	6,5	**MonoCoral**
2013	Dillingen Rogesa	Dillingen	Germany	4	11,2	**MonoGuard**
2012	HKM	Huckingen	Germany	B	11	**MonoCoral Coranit®**
2011	Bhilai steel	Bhilai	India	8	13,4	**Refrax® 20 SBF**
2011	Voest Alpine Do-nawitz	Donawitz	Austria	4	8	**MonoCoral**

BOSH & STACK

125 references Bosh and 87 for Stack since 1982:

Year	CUSTOMER	LOCATION	COUNTRY	BF-N.	HEARTH DIA (M)	BOSH	STACK
2021	WELSPUN	Anjar	India	1	5,5	**Sicanit AL3**	-
2021	Voest Alpine Stahl	Linz	Austria	5	8,0	**Sicanit AL3**	-
2020	ArcelorMittal Taranto	Taranto	Italy	4	10,8	**Sicanit AL3**	-
2018	Stelco	Stelco	Canada	1	10,1	-	**Refrax® 20 SBF KE60**
2018	TATA Port-Talbot	Port-Talbot	Great-Britain	5	10,8	-	**Sicanit AL3**
2017	Voest Alpine Stahl	Linz	Austria	A	12	-	**Refrax® 20 SBF**
2017	USS Gary	Gary	USA	8	-	-	**Refrax® 20 SBF**
2016	ArcelorMittal	Bremen	Germany	2	12	**Refrax® 20 SBF**	-
2016	NLMK	Lipetsk	Russia	7	13,1	**Sicanit AL3**	-
2014	JSW Dolvi	Dolvi	India	1	13,8	**Sicanit AL3**	-
2014	Bhushan Steel Ltd	Orissa	India	2	13	**Sicanit AL3**	-
2014	HKM	Huckingen	Germany	B	11	**Refrax® 20SBF**	**MS10**
2014	SG PAM	Pont à Mous-son	France	3	5,68	**43% Al2O3**	**43% Al2O3**
2013	Tata steel Ltd	Kalinganagar	India	1	13,9	-	-
2013	Voest Alpine Stahl	Linz	Austria	A	12	**Coranit®**	-
2013	ArcelorMittal	Newcastle	S.Africa	5	10,14	**Refrax® 20 SBF**	-
2013	Dillingen Rogesa	Dillingen	Germany	4	11,2	**48% Al2O3**	-
2012	Berry Metal (USS)	Ecorse	USA	-	-	-	**Sicanit AL3**
2012	Berry Metal (USS)	Kosice	Slovakia	2	10,8	-	**Sicanit AL3**
2012	Berry Metal (USS)	Gary	USA	14	12,395	-	**Sicanit AL3**

Derwent Top 100 Global Innovator 2021

Clarivate Analytics

SAINT-GOBAIN 2021

1 in 4 products did not exist 5 years ago

166.000+ employees

sales of **€ 44.2** billion

represented in **75** countries

-23% carbon emissions reduction (vs. 2017 on scope 1+2)

8 main R&D centres

OUR MISSION

Saint-Gobain designs, manufactures and distributes materials and solutions which are key ingredients in the well-being of each of us and the future of all.

OUR PURPOSE

MAKING THE WORLD A BETTER HOME.

WE ARE COMMITTED TO BEING CARBON FREE BY 2050.

SAINT-GOBAIN

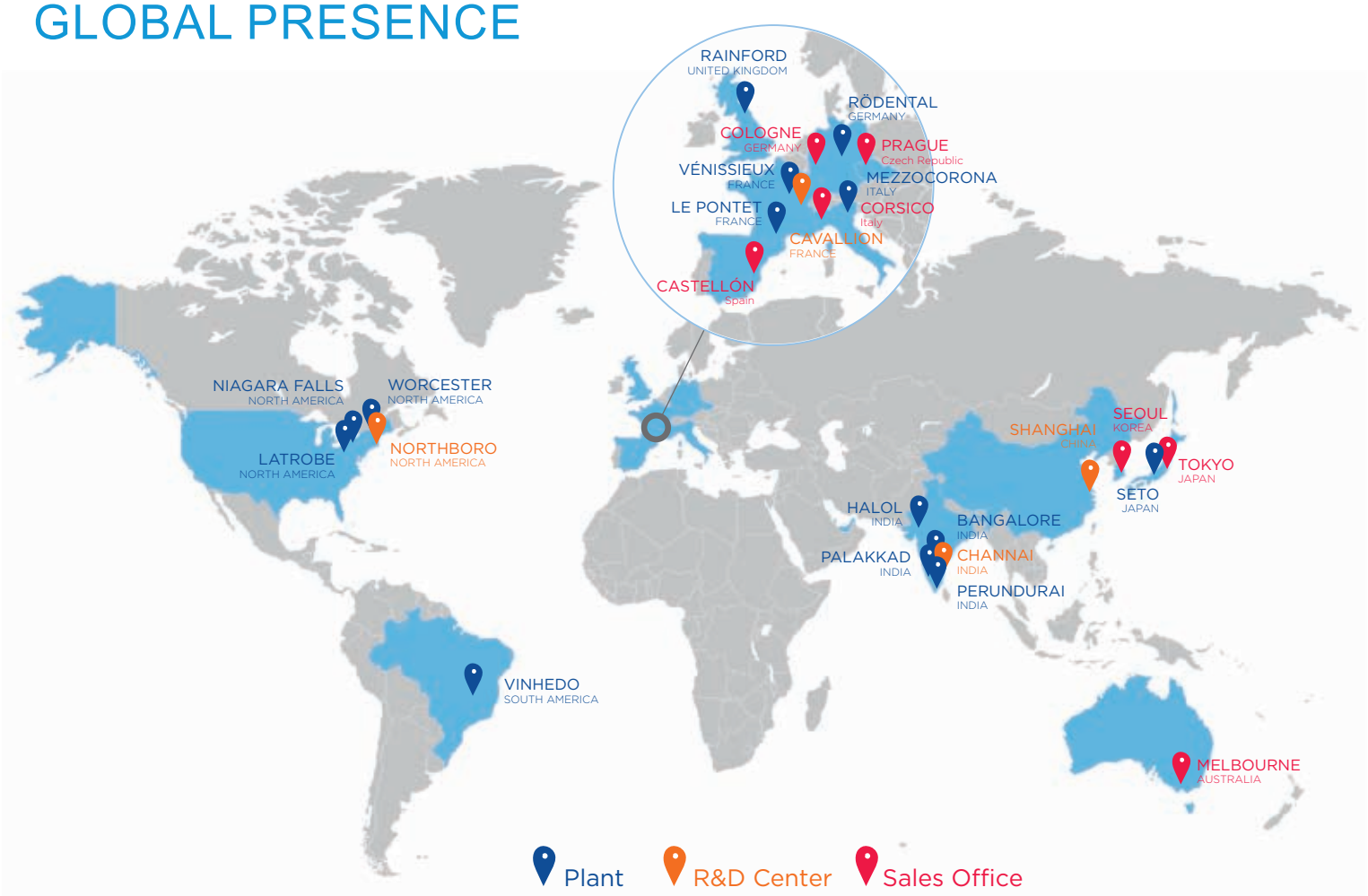
PERFORMANCE CERAMICS & REFRACTORIES

OUR MISSION

To design, develop and **supply solutions** and **services** for **extreme operating industrial conditions.** Our **engineered ceramics** and **refractory** products are manufactured to the **highest industrial standards** and deliver **enhanced performance** while **minimizing environmental impact.**

PIONEERING CERAMIC SOLUTIONS FOR EXTREME INDUSTRIAL APPLICATIONS AND A GREENER WORLD.

GLOBAL PRESENCE



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PERFORMANCE CERAMICS & REFRACTORIES

SAINT-GOBAIN