FIVEN

INNOVATION AT FIVEN

SIKA® MET

SIKA
Silicon Carbide

FIVEN - WE SHAPE INDUSTRIES

Fiven is the leader in the production of Silicon Carbide. Based on long time experience and industrial expertise, we are delighted to provide a wide range of high quality products combined with excellent services. Together with our customers we are expanding in growing markets by increasing our production and processing capacities. Our goal is to improve the performance of our clients' products, to improve the efficiency of their manufacturing processes and to extend the lifetime of their equipment.

Our Six Key Values

- Respect for the environment, health and safety
- Reliability of supply
- Consistency of quality
- Innovation in conjunction with our customers (co-development)
- Respect of confidentiality for each customer
- Local presence combined with worldwide excellence standards

What is Silicon Carbide?

Silicon Carbide (SiC) is a synthetic mineral most commonly produced in electrical resistance furnaces, by the Acheson process, named after the American E.G. Acheson who invented it in 1891. In an Acheson furnace, a mixture of carbon material (usually petroleum coke) and a silica or quartz sand is reacted chemically at high temperatures in the range of 1700 – 2500°C resulting in the formation of α-SiC following the primary reaction:

$$SiO2 + 3\,C \xrightarrow[+\,618{,}5kJ]{} SiC + 2\,\overrightarrow{CO}$$

The energy for the reaction is provided by the resistive heating of a graphite core by connecting this core to two electrodes at both ends of the furnace.

SiC develops as a solid cylindrical ingot around the core, with radial layers ranging from graphite in the inside, to α-SiC (the highest grade material with coarse crystalline structure), β-SiC (metallurgical grade) and finally un-reacted material on the outside. SiC can be produced as either black or green, depending on the quality of the raw materials. After a cooling period, the SiC ingot is sorted accurately and further processed for different applications. The SiC crude material is carefully crushed, classified, sometimes milled again, and optionally chemically treated to obtain the specific properties for further application purposes. These subsequent processing steps account for the bulk of our know-how and the value we add to our products.

Properties of silicon carbide

SiC is a ceramic material with an outstanding hardness, only surpassed by diamond, cubic boron nitride and boron carbide. The material is highly wear-resistant and chemically inert to all alkalies and acids, and it is also highly heat resistant. These properties make silicon carbide an outstanding abrasive and ceramic material to be used under extreme operating conditions.

TYPICAL PROPERTIES (SiC CRYSTAL)

Density	**3.21 g/cm³**
Vickers Hardness	**29 GPa**
Coefficient of thermal expansion	**5.10⁻⁶ /K**
Thermal conductivity	**50 to 100 W/m K**
Temperature resistance	in air **1500 °C** in inert atmosphere **2400 °C**
Specific heat	**750 J/kg K**

High purity

The high purity of metallurgical silicon carbide reduces the level of harmful waste elements contained in other materials. In this context, silicon carbide becomes a good alternative as a source of silicon and carbon in cast iron.

		Alloys traditionally used	
Impurities	Silicon carbide	Silicon alloys	Sources of carbon
Aluminum	low	high	-
Nitrogen	low	-	high
Hydrogen	low	-	high

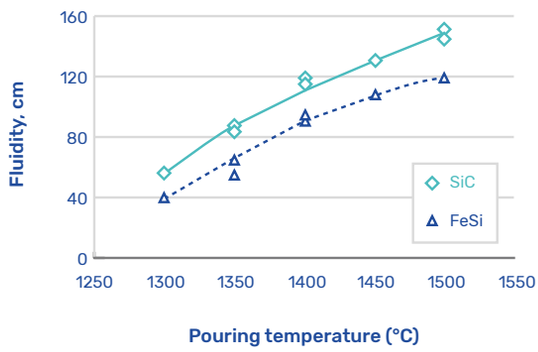
Typical chemical composition of metallurgical silicon carbide

Element	Content	Element	Content
SiC	86,50%	**Cd**	<0.01%
Si - Connected to SiC	60,55%	**Co**	<0.050%
C - Connected to SiC	25,95%	**Cr**	0.07%
C free	6,15%	**Mo**	<0.050%
SiO2	4,50%	**Mn**	<0.050%
Al free	0,20%	**Ni**	<0.050%
Si	0,40%	**P**	<0.050%
S	0,03%	**Sb**	<0.050%
H	0,03%	**Se**	<0.050%
N	0,03%	**Sn**	<0.050%
Fe	0,70%	**Te**	<0.050%
Ca	0,30%	**Ti**	0.03%
Mg	<0,050%	**V**	0.02%
As	<0,050%	**B**	-

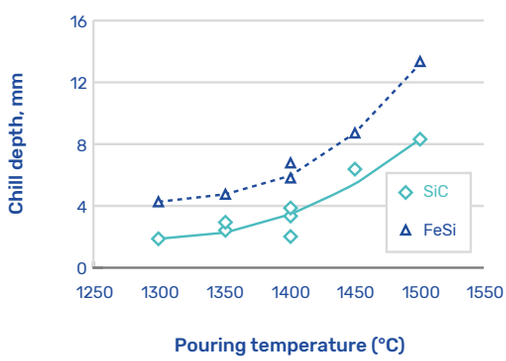
Nucleating effect in cast iron

Silicon carbide has nucleating or preconditioning properties that result in a better quality of cast iron.

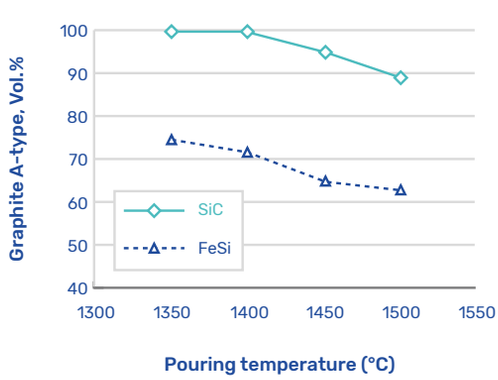
MORE
FLUIDITY



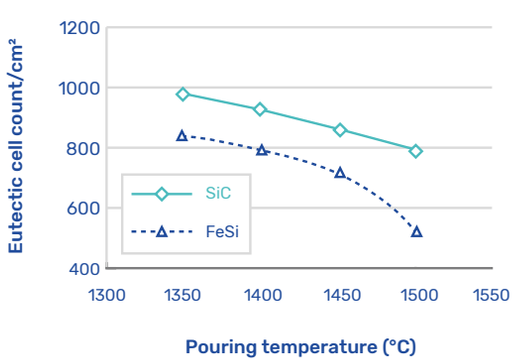
LOWER
CHILL DEPTH

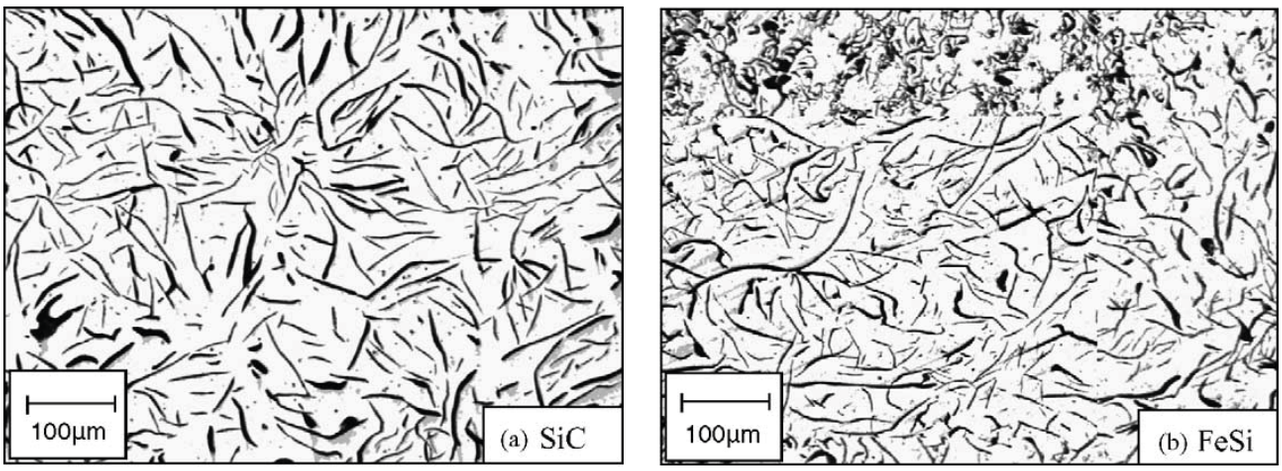


MORE GRAPHITE
A-TYPE FORMATION



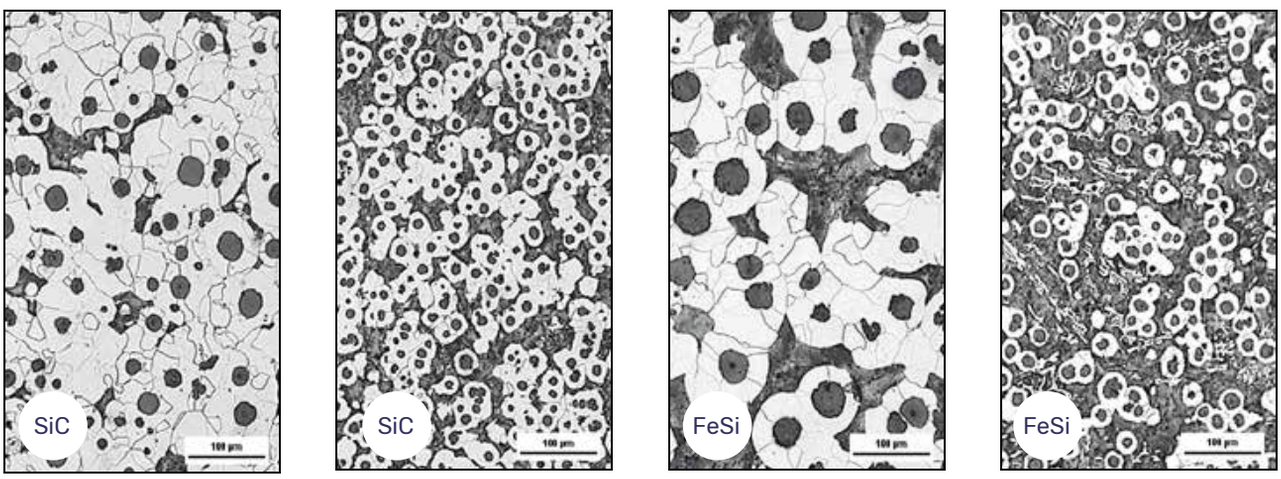
MORE
EUTECTIC CELLS





Source: Edalati, F. Akhlaghi, M. Nili-Ahmadabadi, Influence of SiC and FeSi addition on the characteristics of gray cast iron melts poured at different temperatures

• Predominant Graphite A-type formation

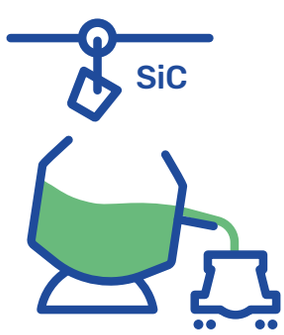


Source: A. VAŠKO. Microstructure and mechanical properties of synthetic nodular cast iron

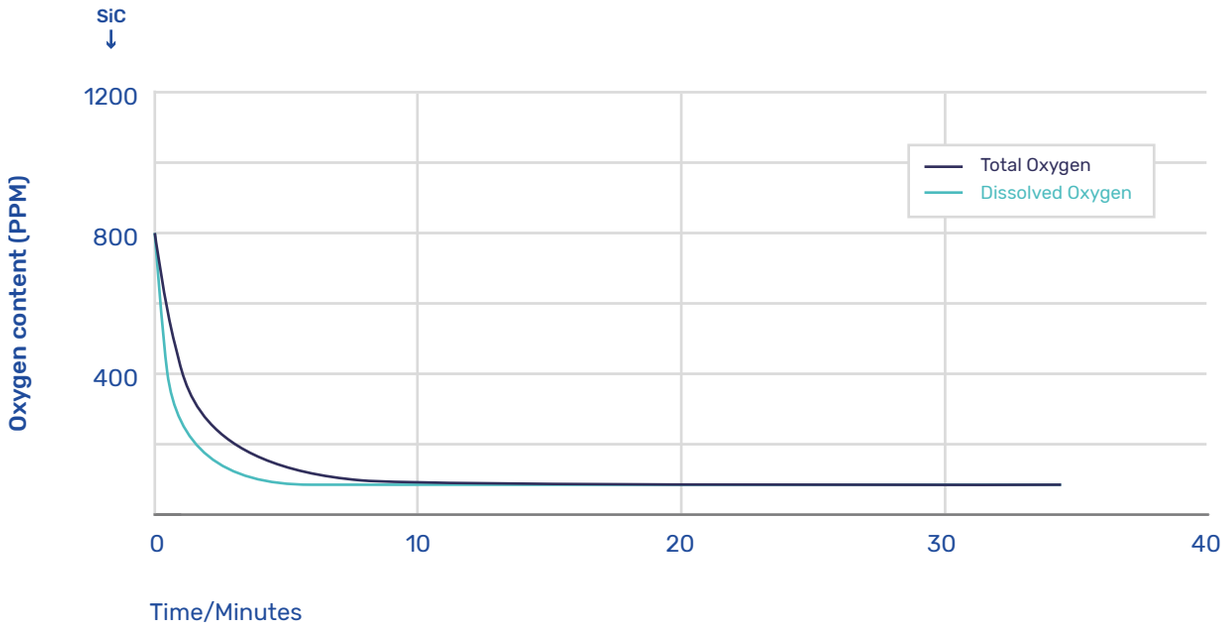
• More nodules in nodular cast iron

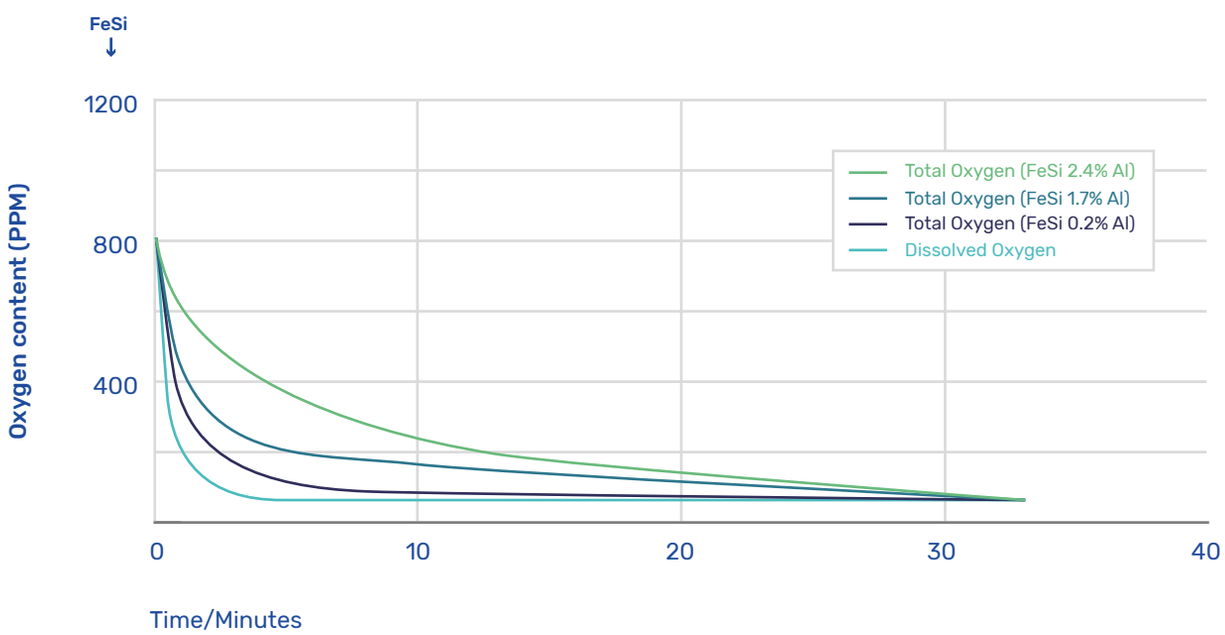
Deoxidizing agent in ladle furnace

Silicon carbide functions as a good deoxidizing agent during the transfer of the liquid metal from the electric furnace to the ladle. The deoxidation kinetics is similar to ferrosilicon alloys. However, silicon carbide presents lower levels of impurity (aluminum) than FeSi.
In this way, the possibility of inclusions (Al_2O_3) in the material obtained by the process that uses silicon carbide is smaller compared to the use of ferrosilicon, which guarantees a higher quality of the final product.



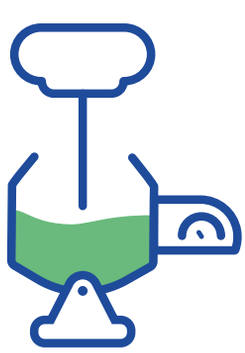
- Quick deoxidation of the bath
- Less probability of forming inclusions in the final product





Exothermal agent in converters (LD/BOF)

As a thermal input in LD/BOF converters, silicon carbide is an excellent material. Both silicon and carbon generate an exothermic reaction capable of releasing energy into the process (equations 1 and 2). Due to carbon being a part of the exothermic reaction, the chemical composition of the generated slag is much less acidic than the process used by other alloys. Thus the consumption of lime in the process using SiC is lower compared to the process with other exothermic agents.



<Si> + (O_2)= <SiO_2> ΔH=-901,76KJ/Mol Equation 1
<C> + (O_2)= (CO_2) ΔH=-393,04KJ/Mol Equation 2

SiC is used as thermal input in the following situations:
• Pig iron with low initial temperature
• High scrap content in the BOF converter

Products with silicon carbide

Foundry industry

Induction furnace

Silicon carbide provides silicon and carbon to the melt in induction furnaces.

SIKA ® product	Grit size	SiC content	Application
SIKA ® MET	0x10 mm	85%	Alloying element / Pre-conditioning
	1x10 mm	85%	

Cupola furnace

Briquettes of silicon carbide add silicon and carbon into the cupola furnace providing deoxidizing and higher melt rate due to the lower consumption of coke.

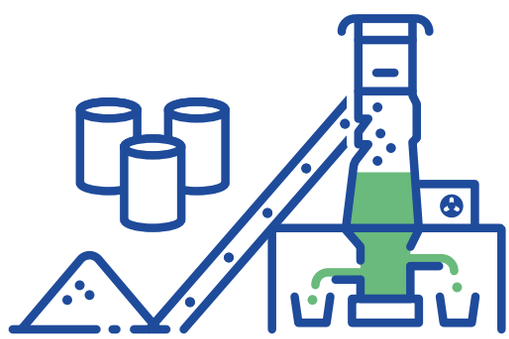
SIKA ® product	Grit size	SiC content	Application
SIKA ® MET	Briquettes	70%	Alloying element / Pre-conditioning
	Injection grade	90%	

Steel Industry

LD/BOF

Silicon carbide is a powerful fuel for BOF steel-making because of providing energy to the process. By adding silicon carbide, steel-making can raise the temperature within the LD furnace and increase the usage of scrap being more cost-effective. The exothermic property of silicon carbide is more cost-effective compared with ferrosilicon; in addition silicon carbide has lower impurities than Sulfur and Aluminum.

SIKA ® product	Grit size	SiC content	Application
SIKA ® MET	Pellet	70%	Exothermic agent / Promote slag formation
	Briquette	70%	
	10x60 mm	85%	



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