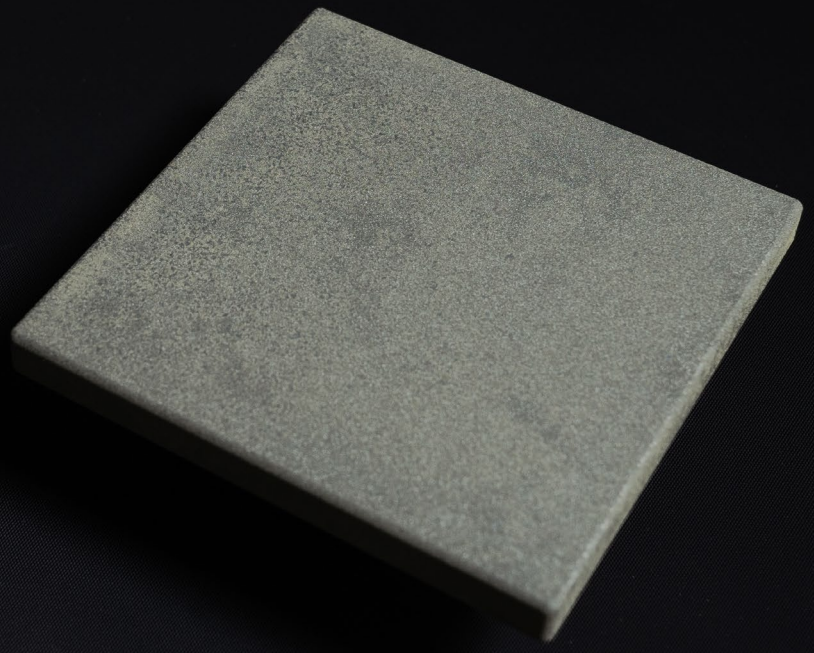
SICCOTA®

EFFICIENT PROTECTION OF GRAPHITE MATERIALS AGAINST CORROSION & OXIDATION

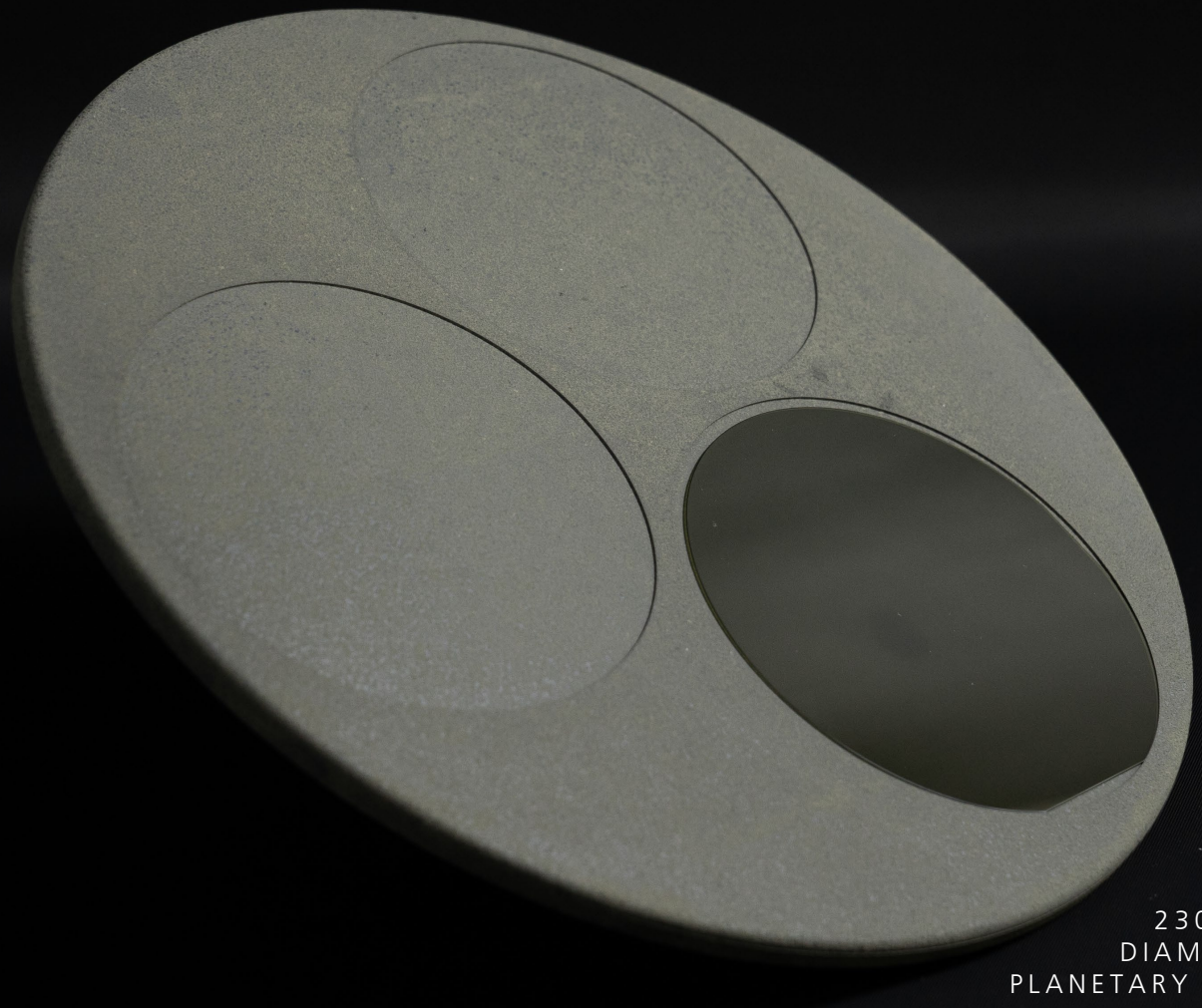


NIPPON KORNMEYER

Fraunhofer IISB

SICCOTA®

INCREASES LIFETIME OF GRAPHITE PARTS IN EPITAXY PROCESSES



230 mm
DIAMETER
PLANETARY DISC

EFFICIENT PROTECTION

Nippon Kornmeyer Carbon Group GmbH and Fraunhofer IISB present their 2nd innovative and patented coating technology SICCOTA®.

The corrosion and oxidation resistant SiC coating can be applied to isostatic pressed graphite substrates and used in semiconductor production and processing steps along the value chain. SICCOTA® protects graphite parts from decomposition and corrosion in typical high temperature and reactive gas processes like SiC / nitride epitaxy and oxidation, resulting in longer lifetime and improved cost of ownership.

R&D BY FRAUNHOFER IISB:

- Delivery of test parts and application demonstrators
- Application testing support
- Custom tailored coating developments and short feedback loops
- R&D project collaboration

PARTS SUPPLY BY NIPPON KORNMEYER CARBON GROUP GMBH:

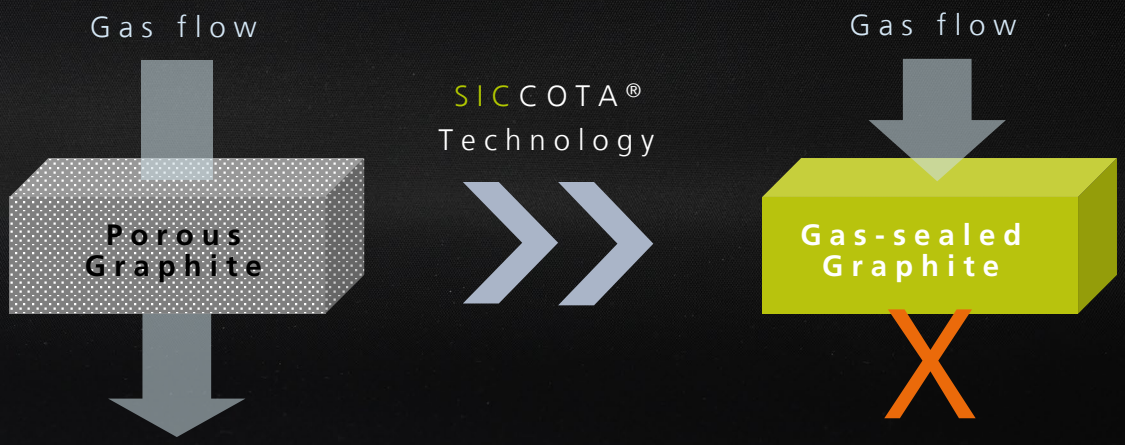
- From small batches to relevant production quantities

SICCOTA®

EFFICIENT SURFACE SEALING

The SICCOTA® coating technology utilizes a dense SiC layer resulting in a highly efficient surface sealing of the porous graphite substrate.

As a result, the gas permeability of graphite materials is drastically reduced by sealing the surface near pores during the coating process.



Darcy's Permeability tests (according to EN 993-4 : 1995) of SICCOTA® samples show a gas permeability of at least three orders of magnitude lower in comparison to original state.

ADVANCED COATING TECHNOLOGY

INCREASES SERVICE LIFE OF GRAPHITE PARTS AND MAKES SEMICONDUCTOR PROCESSES MORE ECONOMIC

COATING FEATURES AND BENEFITS

- Protection of graphite part (avoidance of contact reactions)
- High temperature resistance (>1600°C)
- Resistance against corrosive, reducing and oxidizing gases
- Wear resistance and excellent adhesion to the substrate
- Low gas permeability due to highly dense crystalline SiC-structure

TECHNOLOGY BENEFITS

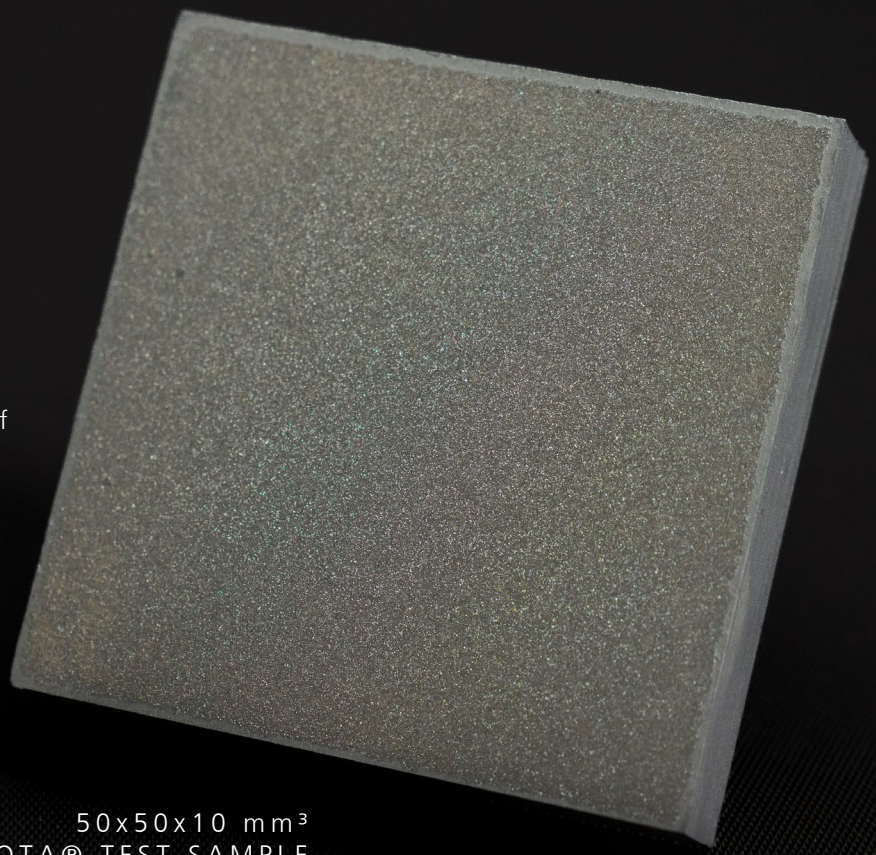
- Applicable to graphites of different porosity & thermal expansion (CTE)
- Flexibility in part size and geometry
- Partial and all around coating possible
- Resource efficient and environmentally friendly
- Use of conflict-free materials only

SICCOTA®

EXCELLENT MECHANICAL PROPERTIES

- Cross cut test after DIN EN ISO 2409:2013-06 revealed that SICCOTA® is classified as ISO 0

- Pull off test after DIN EN ISO 4624:2014-06 shows **8 MPa** adhesive strength to the graphite substrate before failure of the adhesive used for the measurements



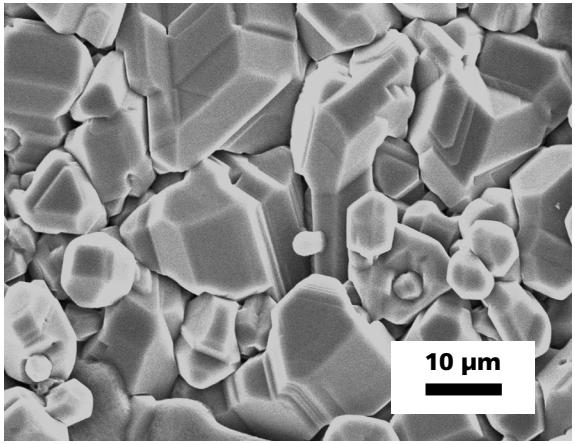
50x50x10 mm³
SICCOTA® TEST SAMPLE

COATING MORPHOLOGY

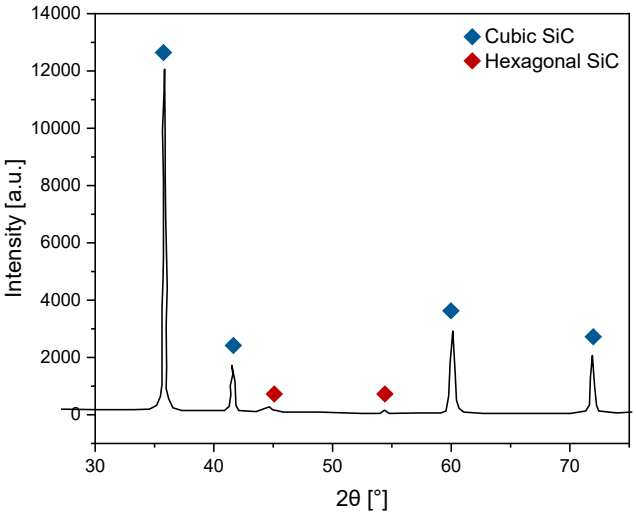
HIGH QUALITY SILICON CARBIDE LAYER

The dense polycrystalline SiC layer mainly consists of cubic SiC (99.97%) and therefore is a proper candidate for protection of graphite parts.

SEM-IMAGE OF THE SICCOTA® COATING SURFACE



XRD-DIFFRACTOGRAM OF THE SICCOTA ® COATING



Contactless measurements of the coating surface with a 3D-Profilometer shows an average roughness R_a of 1-2 µm.

SICCOTA®

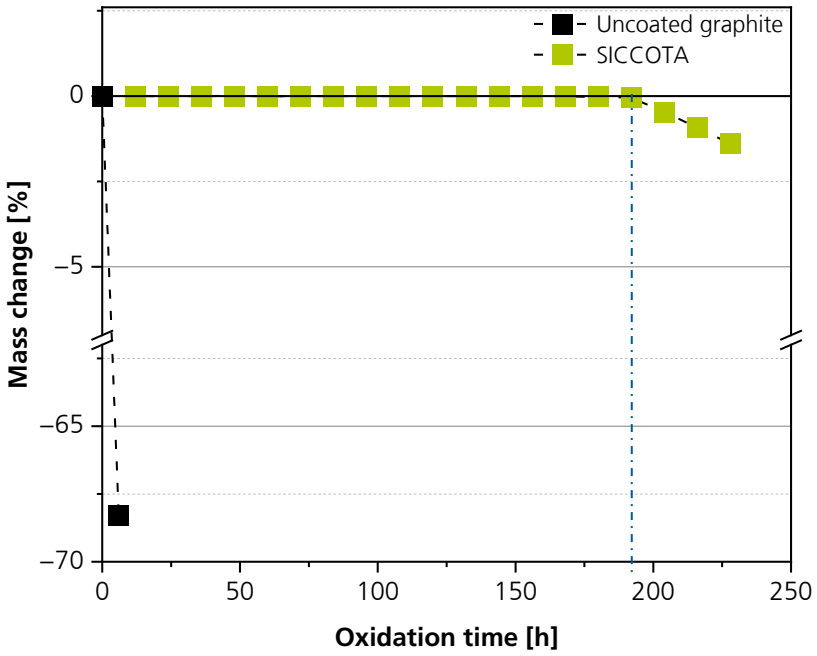
INCREASES LIFETIME OF GRAPHITE PARTS IN OXIDATION PROCESSES

200 mm
DIAMETER
BAFFLE

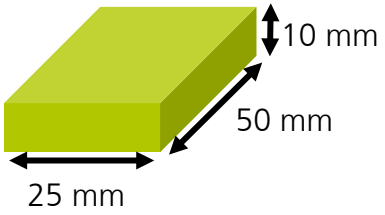
230 mm
DIAMETER
BAFFLE FRAME

HIGH OXIDATION RESISTANCE

OXIDATION OF SURFACE-SEALED GRAPHITE SAMPLES AT 1100°C UNDER CONTINUOUS AIR FLOW

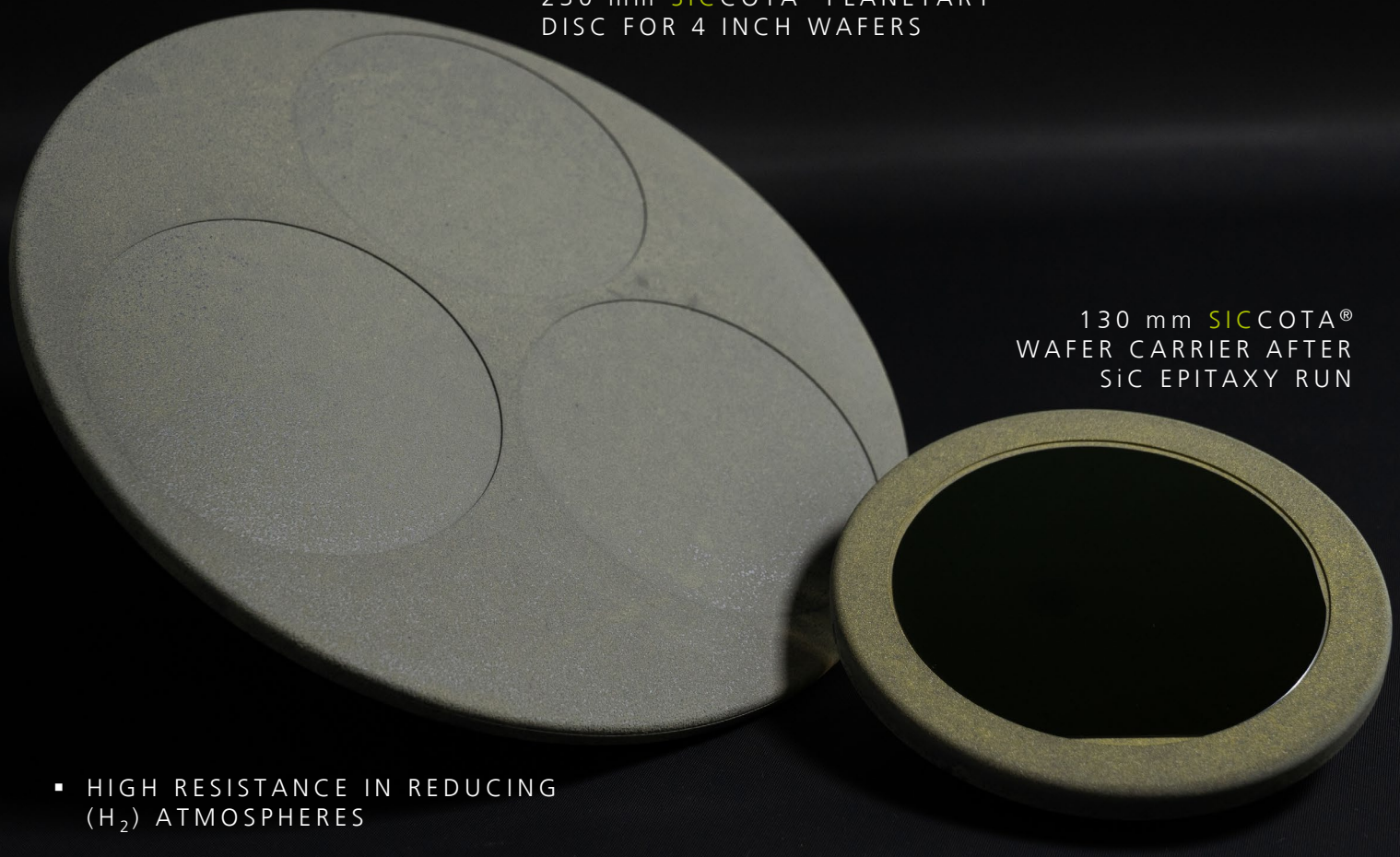


Test sample geometry



To measure oxidation resistance, the mass change [%] of a sample in an oxidizing environment was measured at time increments. Increased oxidation resistance of the SICCOTA® treated graphite was confirmed with no mass change after 192 hours in an oxidizing environment.

SICCOTA® WITHSTANDS SiC EPITAXY CONDITIONS



230 mm SICCOTA® PLANETARY DISC FOR 4 INCH WAFERS

130 mm SICCOTA® WAFER CARRIER AFTER SiC EPITAXY RUN

- HIGH RESISTANCE IN REDUCING (H_2) ATMOSPHERES
- LOW CONATAMINATION LEVEL OF PROCESSED SiC WAFERS

LOW CONTAMINATION LEVEL OF SiC WAFER

AFTER EPITAXY RUN USING SICCOTA® WAFER CARRIER

Detection limit (dl)	Species	Processed SiC Wafer (Si-plane)		Unprocessed SiC-Wafer (Si-plane)	Industrial epitaxy process
0.031	**Li**	<dl		<dl	n.m.
0.126	**Na**	7.157		1.068	n.m.
1.125	**Al**	1.583		<dl	n.m.
0.115	**K**	11		0.364	0.053
0.738	**Ca**	2.641		18.78	<dl (0.05)
0.016	**Ti**	1.52		<dl	<dl (0.03)
0.063	**V**	1,58		<dl	<dl (0.02)
0.471	**Cr**	<dl		<dl	0.105
0.051	**Mn**	<dl		<dl	0.488
0.270	**Fe**	0.385		<dl	0.306
0.108	**Co**	0.412		<dl	<dl (0.02)
0.363	**Ni**	1.448		<dl	<dl (0.25)
0.618	**Cu**	<dl		<dl	<dl (0.14)
0.032	**Zn**	0.3		<dl	<dl (0.05)
0.565	**As**	<dl		<dl	<dl (0.21)
0.015	**Sr**	<dl		<dl	<dl (0.003)
0.008	**Cd**	<dl		<dl	<dl (0.004)
0.010	**Ba**	0.012		0.051	<dl (0.001)
0.001	**Ta**	0.077		0.066	0.058
0.012	**Pb**	<dl		<dl	<dl (0.002)
0.002	**Bi**	<dl		<dl	<dl (0.001)

Values for surface contamination in 1E10 at/cm², measured by VPD ICP-MS on Si-side (upwards) of virgin & processed epi-ready Ø100 mm SiC-wafer.

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