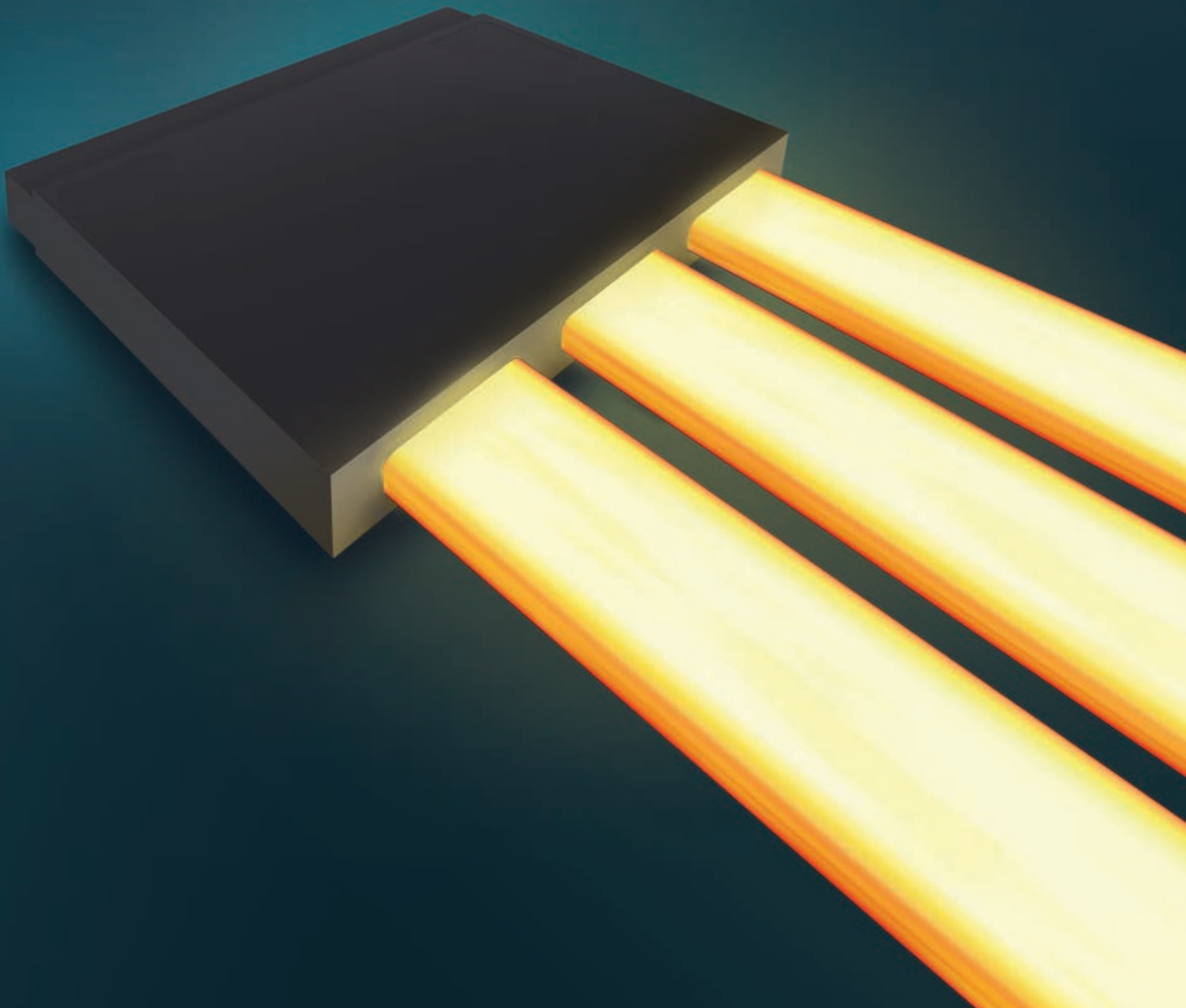




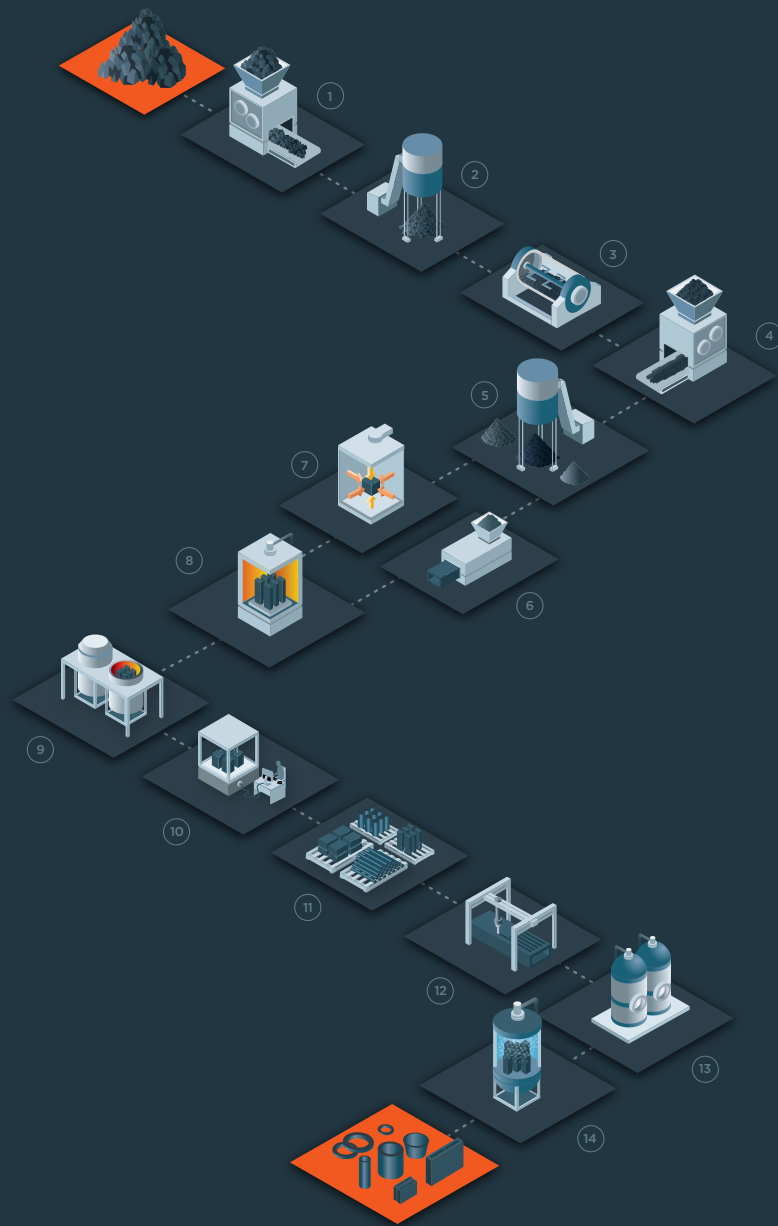
METALLURGY

GRAPHITE
SPECIALTIES
SOLUTIONS FOR
METALLURGY



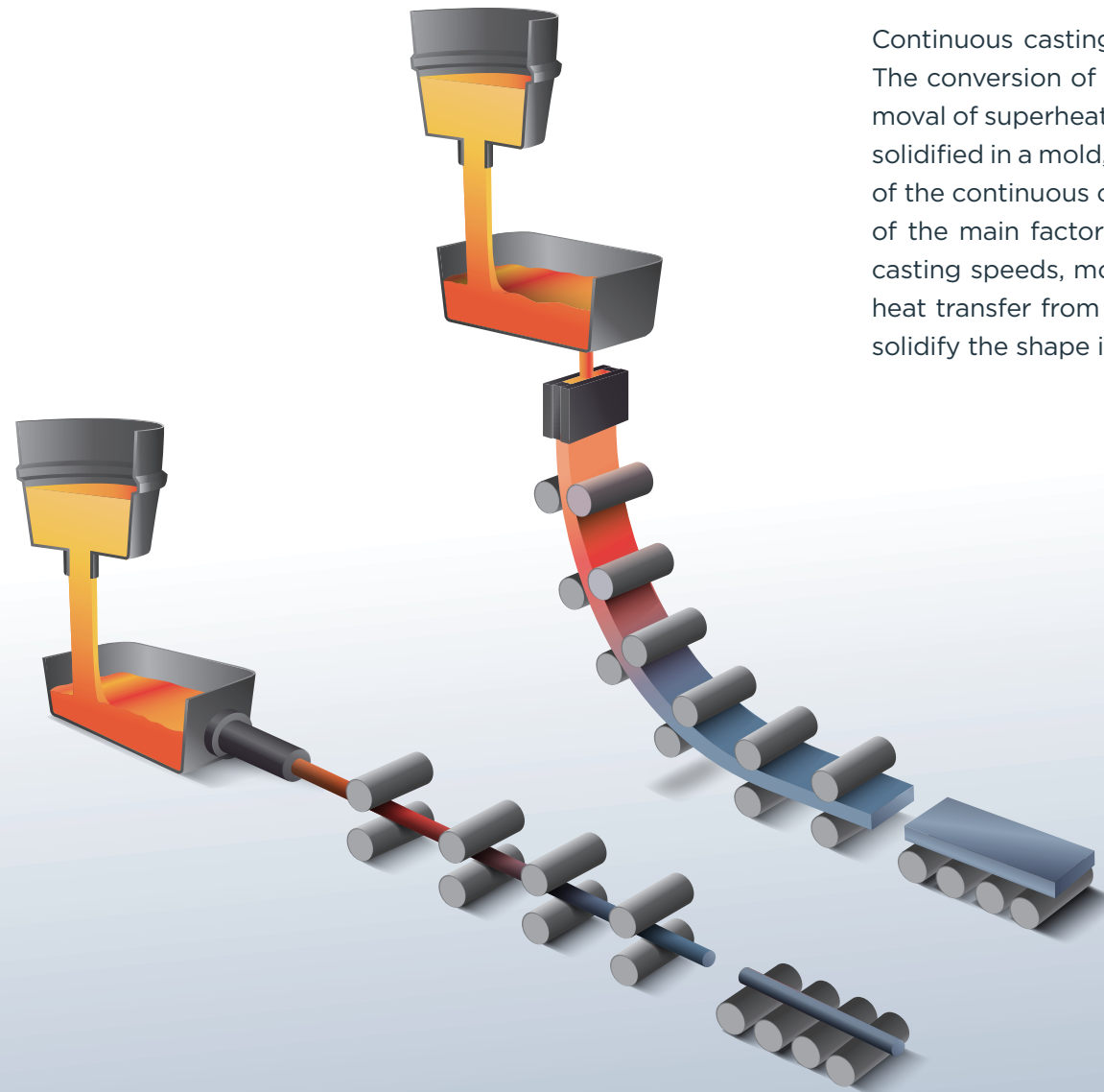
FROM GRAPHITE MANUFACTURING TO FINISHED PRODUCTS

- 0 RAW MATERIALS (natural or recycled graphite, cokes)
- 1 GRINDING
- 2 SIEVING
- 3 BLENDING / MIXING
- 4 GRINDING
- 5 SIEVING
- 6 EXTRUDING / SPINNING
- 7 ISOSTATIC or UNIAXIAL COMPRESSION
- 8 BAKING 1,000°C
- 9 GRAPHITIZATION 3,000°C
- 10 FINAL TESTS
- 11 SEMI-FINISHED PRODUCTS
- 12 MACHINING
- 13 PURIFICATION 2,000°C
- 14 COATING 1,500°C



GRAPHITE COMPONENTS FOR HIGH TEMPERATURES

+ CONTINUOUS CASTING



Why is the graphite mold the most critical component ?

Continuous casting can be considered as a heat extraction process. The conversion of molten metal into a solid metal shape involves removal of superheat and latent heat of solidification. The liquid metal is solidified in a mold, which is the most critical and essential component of the continuous casting equipment. Heat transfer in the mold is one of the main factors limiting the maximum productivity. With higher casting speeds, more heat is transported into the mold and thus the heat transfer from the shape to the mold has to increase in order to solidify the shape in the mold.

+ UNIQUE PHYSICAL CHARACTERISTICS OF GRAPHITE FOR CONTINUOUS CASTING

- withstand molten metal temperatures
- high thermal conductivity
- self-lubrication properties
- exceptional resistance to wear
- excellent mechanical strength
- low Coefficient of Thermal Expansion (CTE)

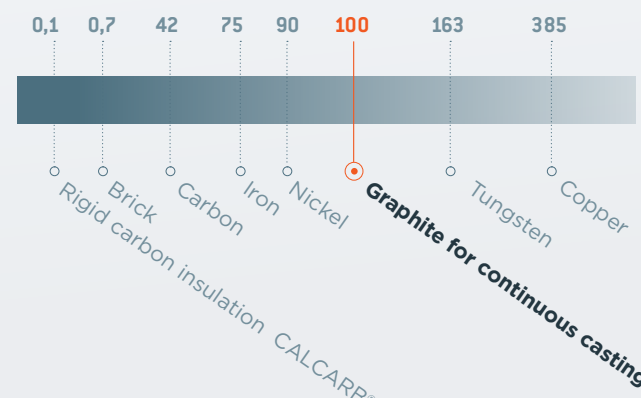
Did you know ?

Unlike most materials, the tensile, compressive and flexural strengths of graphite increase as temperature rises up to 2400 °C

The thermal conductivity of graphite is higher than that of many metals

The Coefficient of Thermal Expansion (CTE) is only about one quarter that of iron.

Typical value of thermal conductivity Material W/m.°K



Melting & boiling points

Tungsten	3,370	5900
Molybdenum	2,620	3,700
Graphite	3,650	
Nickel	1,455	2,900
Gold	1,062	2,856
Copper	1,083	2,600
Boron	2,300	2,550
Silicium	1,410	2,355
Tin	232	2,340
Aluminium	660	2,300
Silver	960,5	2,190
Zinc	420	907

■ SUBLIMATION POINT °C
■ BOILING POINTS °C
■ MELTING POINTS °C

Copper casting challenges & Mersen solutions



BRASS (Cu Zn)

PROCESS CHALLENGES

ZINC VAPORIZATION IN THE DIE

OUR RECOMMANDATIONS

- High porosity needed , >12%
- Focus on high thermal conductivity grades (140 W/m°C) to increase the speed of casting and productivity

YOUR SOLUTIONS

- High porosity grades 1940 (12%) or 2275 (15%)
- High thermal conductivity grades 2275 or 2554 with 140 W/m°C
- 2275 being the grade having the ideal combined properties for brass casting

BRONZE (Cu Sn)

PROCESS CHALLENGES

TIN EVAPORATION IN THE DIE
FAST COOLING NEEDED FOR A GOOD HOMOGENEITY

OUR RECOMMANDATIONS

- High thermal energy removal needed
- High porosity needed

YOUR SOLUTIONS

- High porosity grade, 12% with 1940 and 15% with 2275
- High thermal conductivity grade 2275 and 2554 (140 W/m°C) to increase the speed of casting and get a high productivity and low production cost

NICKEL ALLOYS

PROCESS CHALLENGES

ALLOYS ELEMENTS LIKE NICKEL ATTACK THE GRAPHITE MOLD
RISK OF SCRATCHES ON THE MOLD THROUGH FAST COOLING

OUR RECOMMANDATIONS

- Impregnated graphite solutions for an extended service life
- High density and high hardness grades for long life time

YOUR SOLUTIONS

- High mechanical properties of 2230 graphite grade
- High thermal conductivity for higher speed of casting with 2554 graphite grade

COPPER (Cu-ETP-OF-OF)

PROCESS CHALLENGES

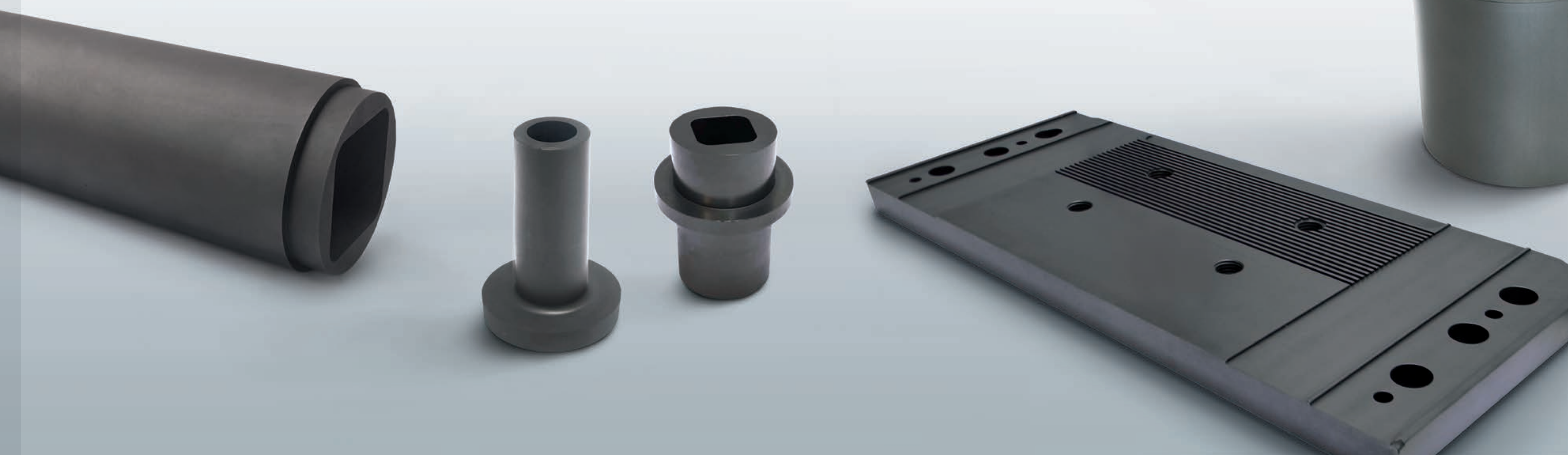
WEAR RESISTANCE
MOLDS MATERIAL FOR EXTENDED LIFE

OUR RECOMMANDATIONS

- Medium conductivity and good hardness for high performances

YOUR SOLUTIONS

- Mersen graphite grades 1940 and 2020 are the references on the market for copper wire
- Mersen graphite grade 2230 is the must for the market of copper strips



ALUMINIUM (Al)

PROCESS CHALLENGES

ROTOR SHAFTS :
OXIDATION PHENOMENA AT
THE SURFACE OF THE MELT

CASTING RINGS :
MATERIAL TO SUPPORT AIR FLOW THROUGH THE
PROCESS FOR BETTER PRODUCTIVITY

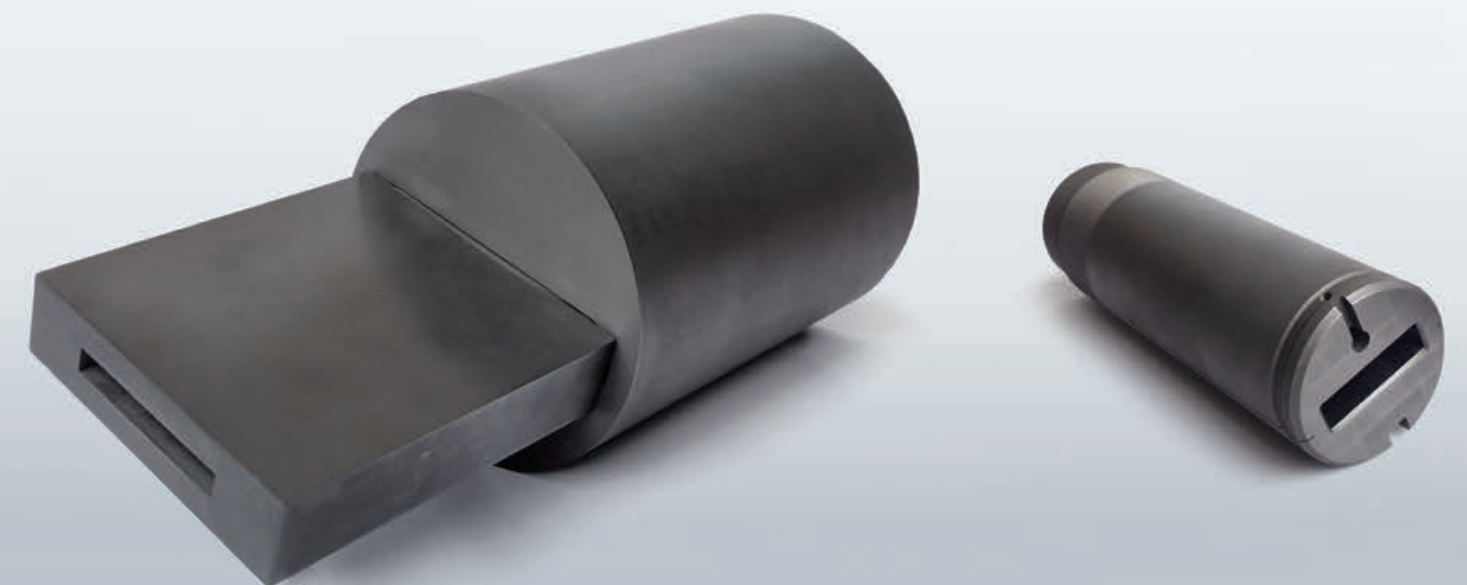
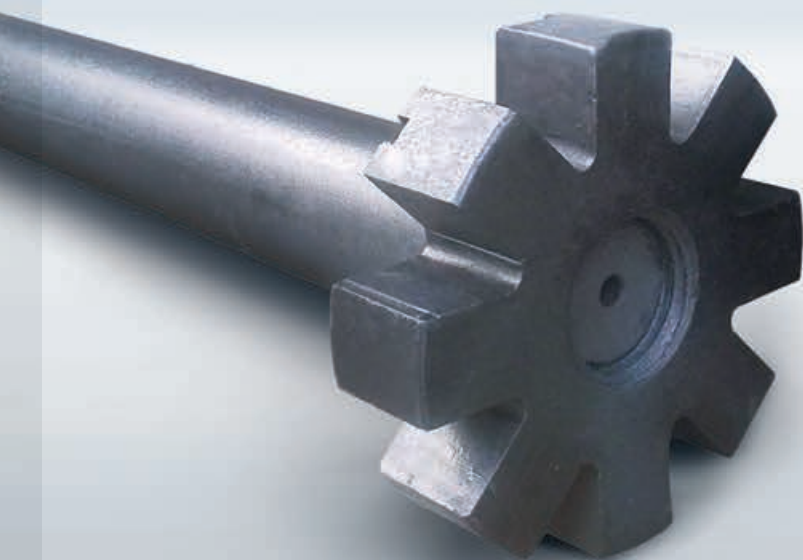
OUR RECOMMANDATIONS

- **Rotor shafts :** anti oxidation material requested
- **Casting rings :** high porosity needed to allow charged air with oil to lubricate the rings

YOUR SOLUTIONS

- **Rotor shafts :** all designs machined on request for optimized gas bubble diffusion and low gas consumption. 6501 or 6172 anti oxidation graphite grade for extended life.
- **Casting rings :** select graphite grades having the right balance between porosity and permeability : 6507 - 1940 - 2275.

Aluminium process challenges & Mersen solutions



Au, Ag, Pd, Pt

PROCESS CHALLENGES

DIES : SHORT RUNS WITH MANY STARTS

CRUCIBLES :
HIGH OXIDATION PHENOMENA; HIGH POWER
CONSUMPTION THROUGH HEAT RAMP UP

OUR RECOMMANDATIONS

Dies :

- High thermal conductivity needed to allow the heat extraction and a high speed of casting
- High density needed and high strength graphite grade to succeed many starts of short runs

Crucibles :

- Material to be selected with an improved electrical resistivity for energy consumption reduction

YOUR SOLUTIONS

Dies :

- 2230 for improved mechanical resistance with its high density.
- 2554 for higher productivity with its super high thermal conductivity.

Crucibles :

- 6507 for a cost effective solution
- 1940 isostatic graphite for its high electrical resistivity

Precious metal process challenges & Mersen solutions



CAST, GREY & DUCTILE IRON

PROCESS CHALLENGES

IRON HAS A TENDENCY TO HAVE AN AFFINITY TO CARBON

OUR RECOMMENDATIONS

- Optimized graphite grades specifications of thermal conductivity and porosity for good performance

YOUR SOLUTIONS

- 1940 graphite grades is the preferred solution being used in the casting of iron

Cast iron challenges & Mersen solutions



+ RECOMMENDED GRAPHITE GRADES FOR DIES AND MOLD

	WIRE CASTING	BILLET CASTING	STRIP CASTING	TUBE CASTING
Grey and ductile iron	-	1940	1940	1940
Brass (Cu-Zn)	2275 - 2554	2275 - 2554	2275 - 2554	1940
Bronze	2275 - 2554	2275 - 2554	2275 - 2554	2236 - 2554
Phosphorus bronze	2220 - 2275	2220 - 2275	2220 - 2275	2236 - 2220 (Core)
Maillechort (Cu-Zn-Ni) nickel-silver	2230 - 2554	2230 - 2554	2554	2220 - 2275
Nickel-copper	2230 - 2554	2230 - 2554	2230 - 2554	2554
Red & Phosphorus, deoxidized copper	1940	1940 - 2220	2230	-
Aluminium	1940	1940 - 2220	2230	-
Silver, Gold	2275 - 2554	-	2230 - 2554	-
Precious metal alloys	2275 - 2554	-	2275 - 2554	2275 - 2554

+ RECOMMENDED GRAPHITE GRADES FOR ROTORS AND SHAFTS

	ROTOR	SHAFT
Aluminium	6507 - 6172 (anti oxidation treatment)	6507 - 6172 (anti oxidation treatment)

+ RECOMMENDED GRAPHITE GRADES FOR CRUCIBLES

	CRUCIBLES
Precious metals	1940 - 6507
Copper Alloys	6507

CONTINUOUS CASTING GRAPHITE SOLUTIONS

TYPICAL CHARACTERISTICS

Property	Unit	ISOSTATIC GRAPHITE						EXTRUDED GRAPHITE	
		2020	1940	2220	2230	2275	2554	6507	6172
Thermal conductivity	W/m°C	85	95	112	112	130	140	Wg 150 Ag 130	200
	Btu-Ft²/Hr°F	49	55	65	65	76	81	Wg 86 Ag 75	116
Density	g/cm³	1,77	1,79	1,84	1,9	1,84	1,88	1,7	1,86
	lbs/ft³	110.5	112	114	118	114	117	107	114
Porosity	%	9	12	8	4	15	9	16	7
Hardness	Shore	52	63	65	76	63	64	34	34
Flexural strength	MPa	45	43	58	59	59	52	Wg 21 Ag 16	23
	psi	6,500	6,300	8,400	8,500	8,500	7,500	Wg 3,050 Ag 2,320	3,300
Compressive strength	MPa	98	89	124	129	116	120	Wg 38 Ag 38	47
	psi	1,400	13,000	18,000	18,750	16,800	17,400	Wg 5,510 Ag 5,510	6,700
CTE (400 to 500°C) (752 to 935°F)	×10 ⁻⁶ / C°	4,3	5,2	5,5	5,4	5,0	4,3	Wg 4,5 Ag 5,1	3,3
	×10 ⁻⁶ / F°	2.4	2.9	3.1	3.0	2.6	2.3	Wg 2.5 Ag 2.83	1.8
Electrical resistivity	μohm.cm	1550	1320	1140	1140	1067	965	Wg 800 Ag 900	800
	ohm-in	0,00061	0,00052	0,00045	0,0005	0,00042	0,00038	Wg 0.00031 Ag 0.00035	0,00031
Average grain size	μm	15	13	13	13	17	10	0,3	0,8
	inch	0,0006	0,0005	0,0005	0,0005	0,0007	0,0004	0,011	0,030
Max Standard block size	mm	1524x1524 x305	508x610 x1829	308x620 x2030	152x620 x915	305x610 x1830	305x610 x915	500x500 x1830	Ø 75 to 200mm*
	inch	60x60x12	20x24x72	12x24x80	6x24x36	12x24x72	12x24x36	20x20x72	Ø 3" x 8" *
Ash	ppm	7500	3000	3000	10000	3000	10000	6500	30000
	%	0,75	0,3	0,3	1	0,3	1	0,65	3

Wg=> With the grain direction Ag=> Against the grain direction

*Length on request

+ MACHINING RECOMMENDATION

MACHINING		SPEED m/min	ADVANCE mm per revolution	DEPTH OF CUTTING in mm
MILLING	ROUGHING	800–1000	0,1–0,8	
	FINISH	1000	<0,09	
TURNING	ROUGHING	100–250	0,3–0,45	5–19
	FINISH	250–450	0,06–0,15	0,1–0,5
GRINDING		100–2300	150–800	<3
SAWING		300–500	300–400	



A local network to serve you

In addition to the graphite grade chosen, the casting results are also a function of die design, quality of machining, and the specific characteristics of the casting installation.

Our grades have been developed in conjunction with foundrymen to obtain the proper blend of physical characteristics for continuous casting. However, in most of the cases, optimal grade can only be selected through in-situ trials

Our local experts will assist you in finding the right graphite grade for your application.



GLOBAL EXPERT IN ELECTRICAL
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MERSEN CHILE
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MERSEN COLOMBIA
Bogota

MERSEN BRAZIL
Sao Paulo

EUROPE & AFRICA

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Schiedam

MERSEN GERMANY
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