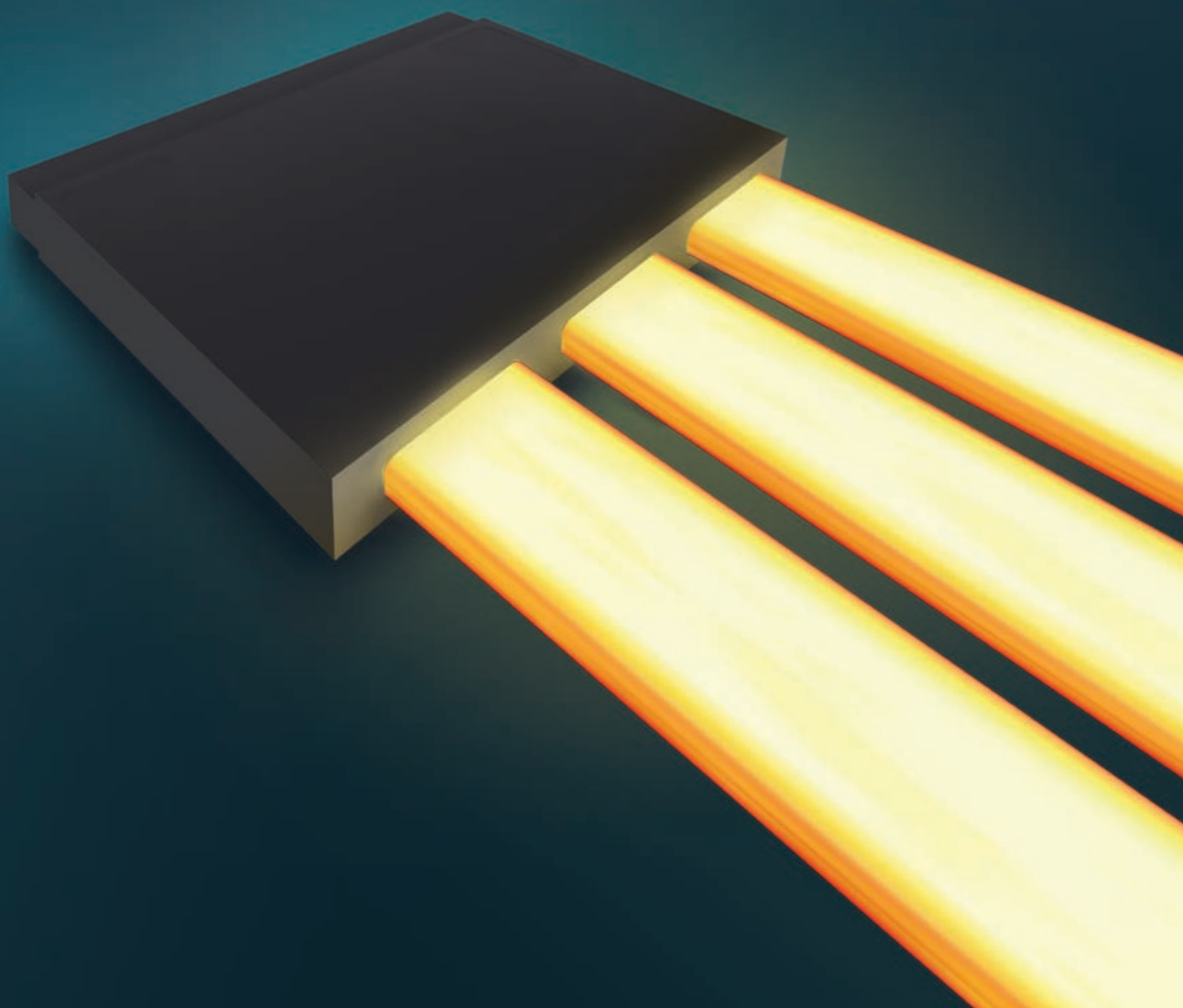




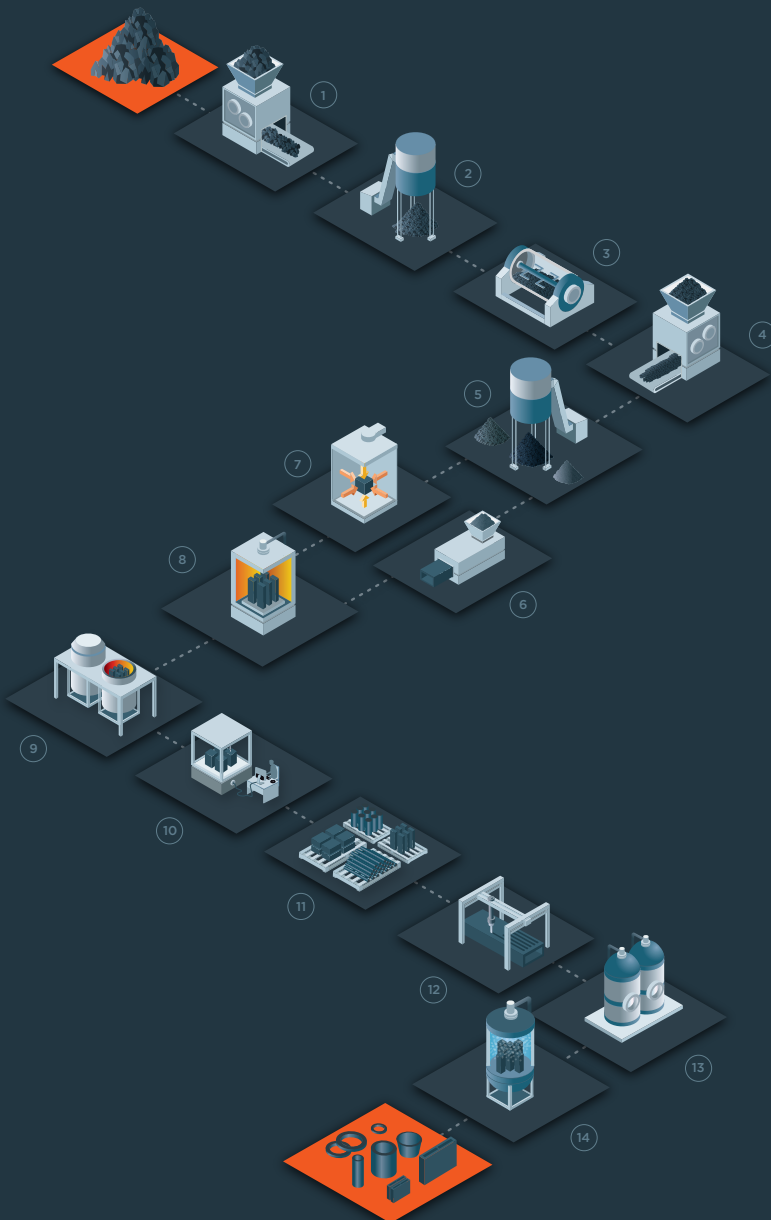
METALLURGY

GRAPHITE
SPECIALTIES
SOLUTIONS FOR
METALLURGY



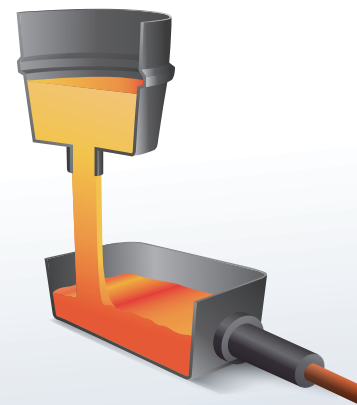
FROM GRAPHITE MANUFACTURING TO FINISHED PRODUCTS

- 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



Did you know ?

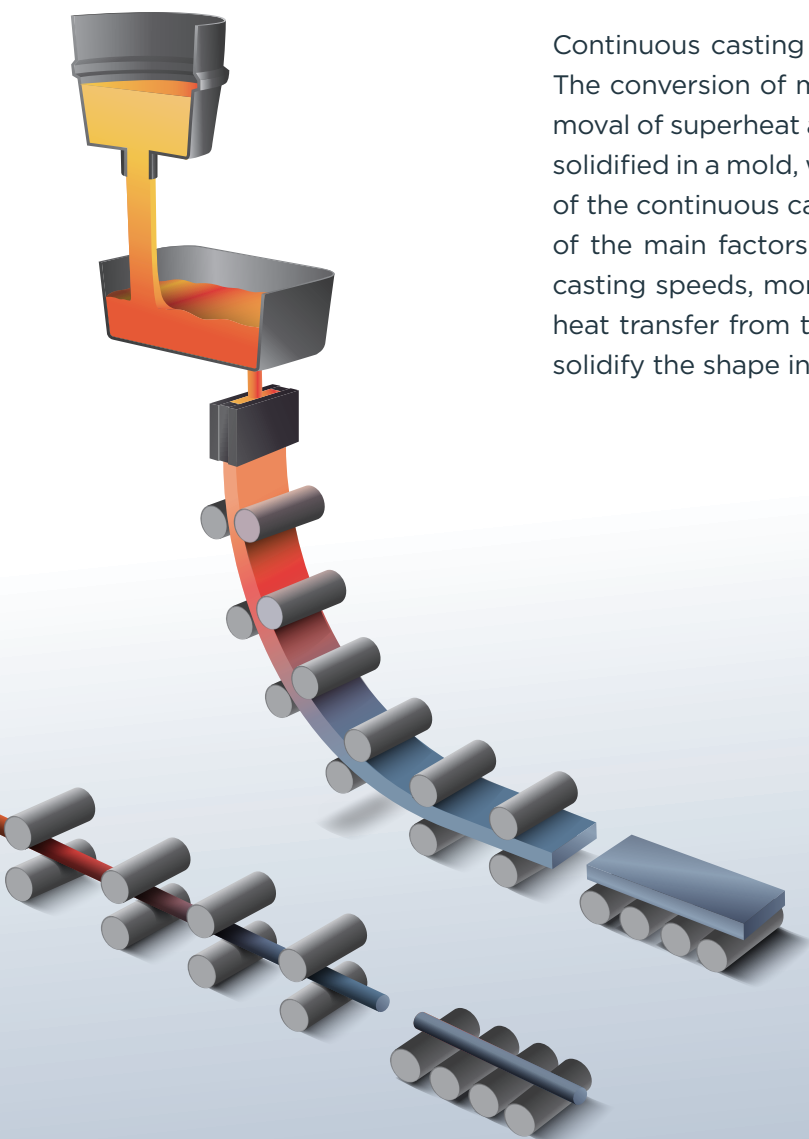
Unlike most materials, the tensile, compressive and flexural strengths of graphite increase as temperature rises up to 2400 °C

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.

Why is the graphite mold the most critical component ?

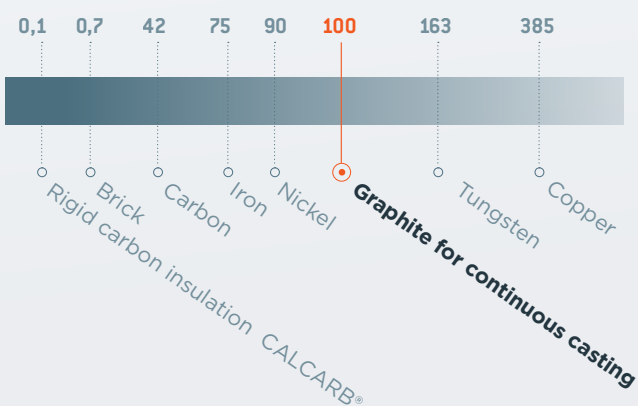
Continuous casting can be considered as a heat extraction process. The conversion of molten metal into a solid metal shape involves removal of superheat and latent heat of solidification. The liquid metal is solidified in a mold, which is the most critical and essential component of the continuous casting 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.



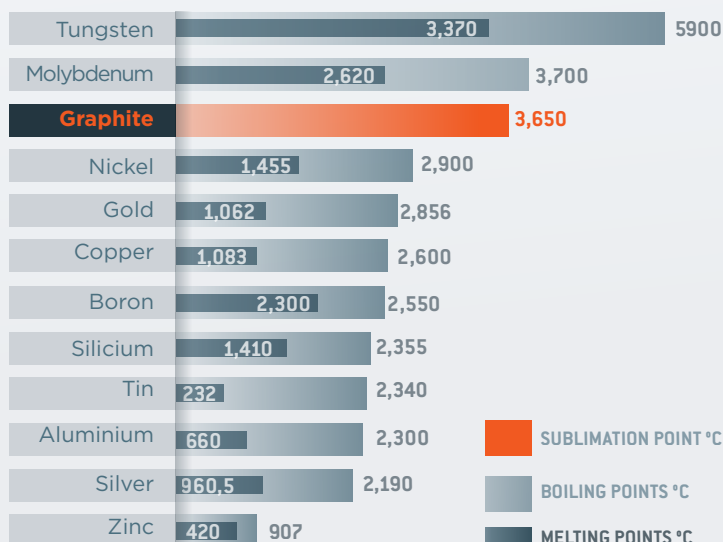
+ UNIQUE PHYSICAL CHARACTERISTICS OF GRAPHITE FOR CONTINUOUS CASTING

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

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



Melting & boiling points



BRASS (Cu Zn)

Copper casting challenges & Mersen solutions



PROCESS CHALLENGES

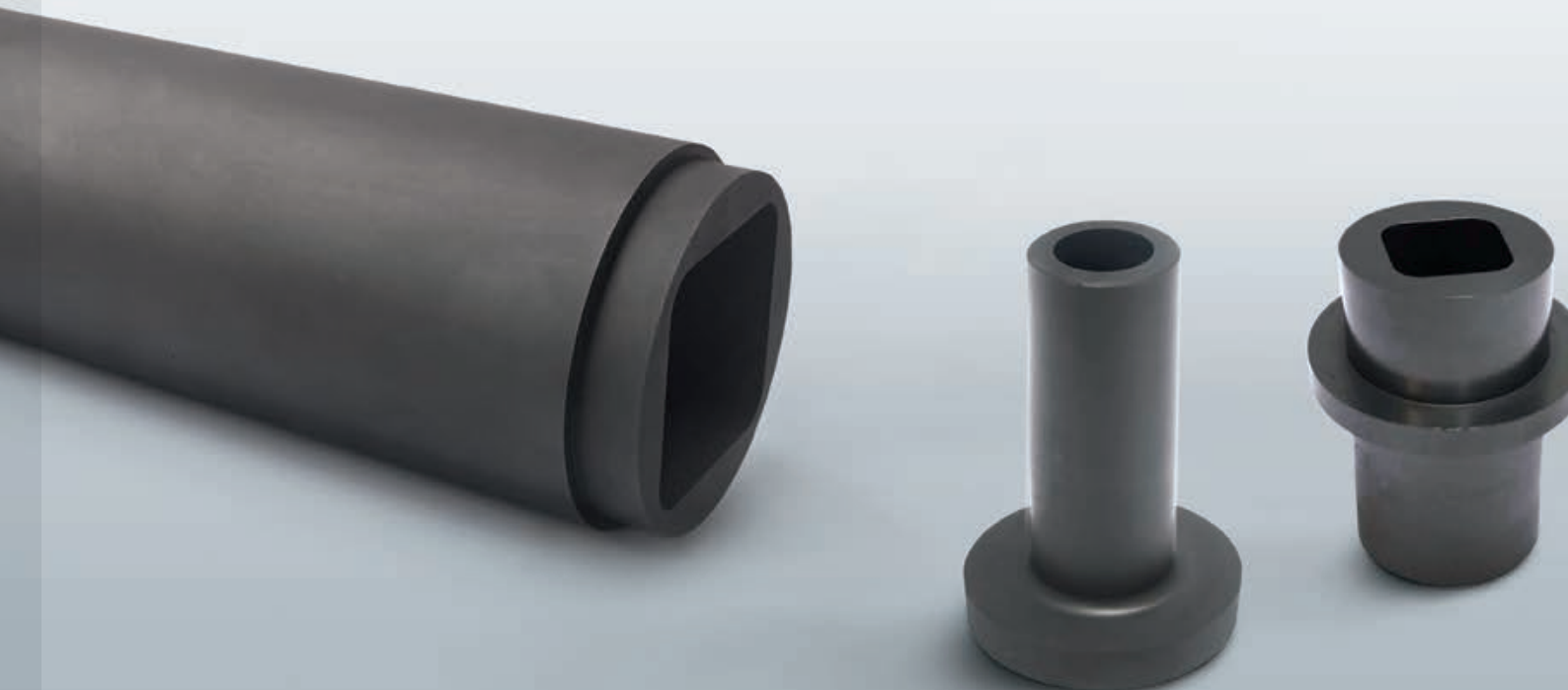
ZINC VAPORIZATION
IN THE DIE

OUR RECOMMENDATIONS

- 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 2236 (15%)
- High thermal conductivity grades 2236 or 2554 with 140 W/m°C
- 2236 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 2236
- High thermal conductivity grade 2236 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 (CuETP-OF-OFC)

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)

Aluminium process challenges & Mersen solutions



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 - 2236.



Au, Ag,
Pd, Pt

Precious metal process challenges & Mersen solutions



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

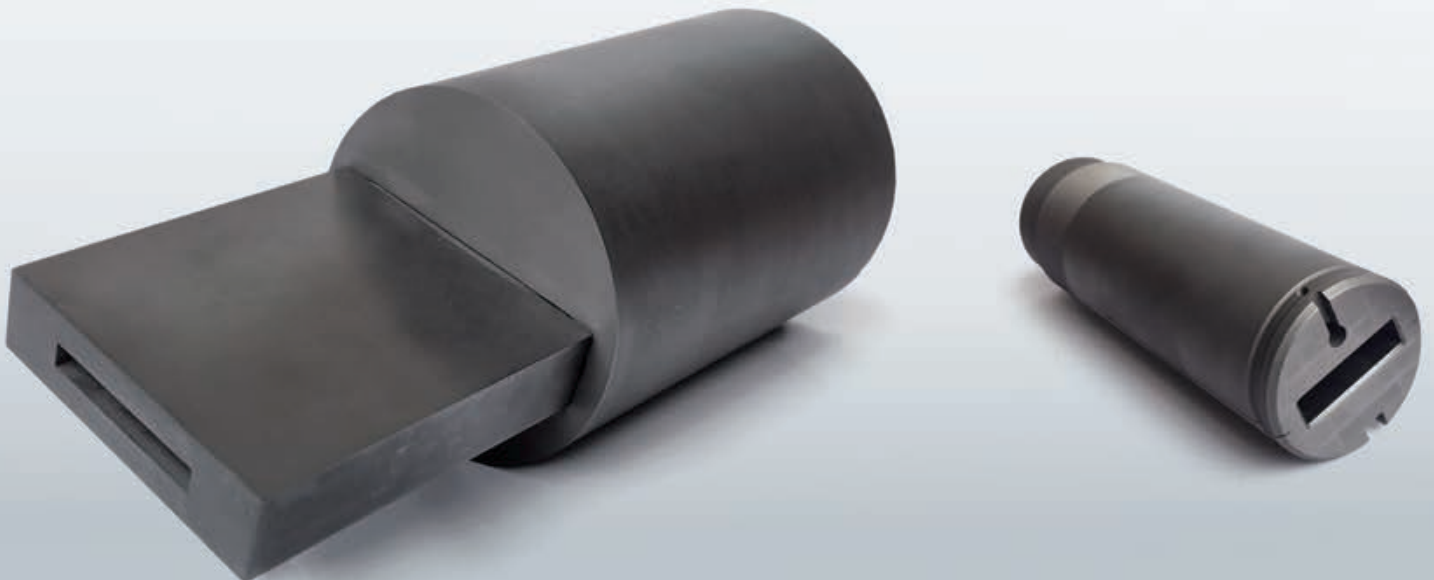
YOUR SOLUTIONS

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



CAST, GREY & DUCTILE IRON

PROCESS CHALLENGES

IRON HAS A TENDENCY TO HAVE AN AFFINITY TO CARBON

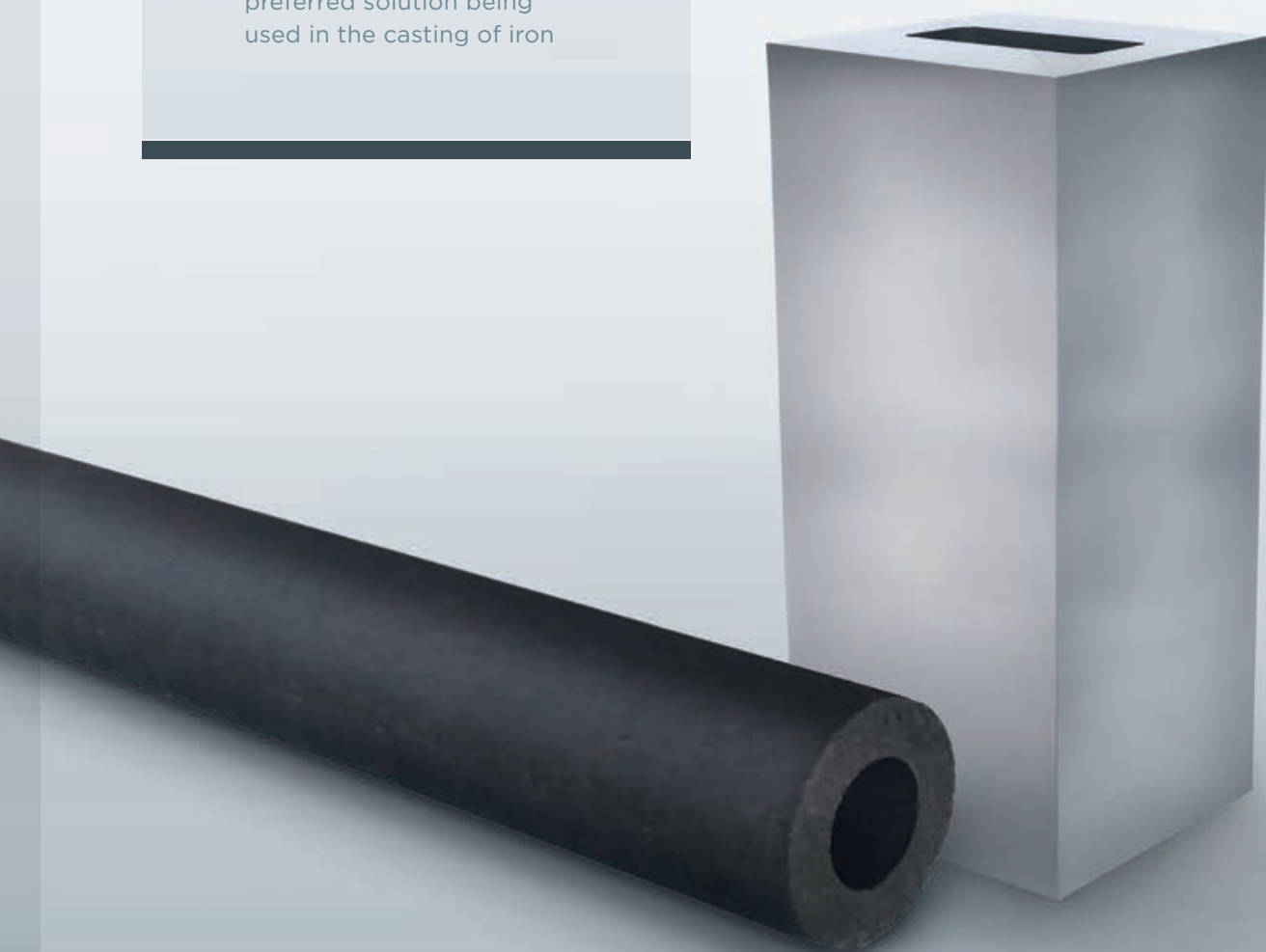
OUR RECOMMANDATIONS

- 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)	2236 - 2554	2236 - 2554	2236 - 2554	1940
Bronze	2236 - 2554	2236 - 2554	2236 - 2554	2236 - 2554
Phosphorus bronze	2220 - 2236	2220 - 2236	2220 - 2236	2236 - 2220 (Core)
Mallechort (Cu-Zn-Ni) _ nickel-silver	2230 - 2554	2230 - 2554	2554	2220 - 2236
Nickel-copper	2230 - 2554	2230 - 2554	2230 - 2554	2554
Red & Phosphorus, deoxidized copper	1940	1940 - 2220	2230	-
Aluminium	1940	1940 - 2220	2230	-
Silver, Gold	2236 - 2554	-	2230 - 2554	-
Precious metal alloys	2236 - 2554	-	2236 - 2554	2236 - 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

		ISOSTATIC GRAPHITE						EXTRUDED GRAPHITE	
Property	Unit	2020	1940	2220	2230	2236	2554	6507	6172
Thermal conductivity	W/m°C	85	95	112	112	140	140	Wg 150 Ag 130	200
	Btu-Ft/Ft²Hr°F	49	55	65	65	81	81	Wg 86 Ag 75	116
Density	g/cm³	1,77	1,79	1,84	1,9	1,78	1,88	1,7	1,86
	lbs/ft³	110.5	112	114	118	111	117	107	114
Porosity	%	9	12	8	4	15	9	16	7
Hardness	Shore	52	63	65	76	55	64	34	34
	Rockwell	95L	98L	80H	85H	80L	90H	25L	25L
Flexural strength	MPa	45	43	58	59	52	52	Wg 21 Ag 16	23
	psi	6,500	6,300	8,400	8,500	7,500	7,500	Wg 3,050 Ag 2,320	3,300
Compressive strength	MPa	98	89	124	129	105	120	Wg 38 Ag 38	47
	psi	1,400	13,000	18,000	18,750	15,200	17,400	Wg 5,510 Ag 5,510	6,700
CTE	x10 ⁻⁶ / C°	4,3	5,2	5,5	5,4	4,0	4,3	Wg 4,5 Ag 5,1	3,3
	x10 ⁻⁶ / F°	2.4	2.9	3.1	3.0	2.1	2.3	Wg 2.5 Ag 2.83	1.8
Electrical resistivity	µohm.cm	1550	1320	1140	1140	965	965	Wg 800 Ag 900	800
	ohm-in	0,00061	0,00052	0,00045	0,0005	0,00038	0,00038	Wg 0,00031 Ag 0,00035	0,00031
Average grain size	µm	15	13	13	13	10	10	0,3	0,8
	inch	0,0006	0,0005	0,0005	0,0005	0,0004	0,0004	0,011	0,030
Max Standard block size	mm	1524x1524 x305	508x610 x1829	308x620 x2030	152x620 x915	308x620 x915	305x610 x915	500x500 x1830	Ø 75 to 200mm*
	inch	60x60x12	20x24x72	12x24x80	6x24x36	12x24x36	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
POWER AND ADVANCED MATERIALS

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St Marys (PA),
Bay City (MI),
Greenville (MI),
Columbia (TN)

MERSEN MEXICO
Monterrey

MERSEN ARGENTINA
Buenos Aires

MERSEN CHILE
Santiago

MERSEN COLOMBIA
Bogota

MERSEN BRAZIL
Sao Paulo

EUROPE & AFRICA

MERSEN BENELUX
Schiedam

MERSEN GERMANY
Suhl & Munich

MERSEN FRANCE
Gennevilliers & Bazet

MERSEN IBERICA
Barcelona

MERSEN TURKEY
Gebze

MERSEN ITALY
Milan & Malonno

MERSEN NORDIC
Kista

MERSEN UK
Teesside & Holytown

MERSEN SOUTH AFRICA
Johannesburg

ASIA & OCEANIA

MERSEN CHINA
Chongqing, Kunshan
& Yantai

MERSEN INDIA
Bangalore & Pune

MERSEN JAPAN
Tokyo

MERSEN SOUTH KOREA
Seoul

MERSEN OCEANIA
Fairfield Victoria

MERSEN TAIWAN
Taipei