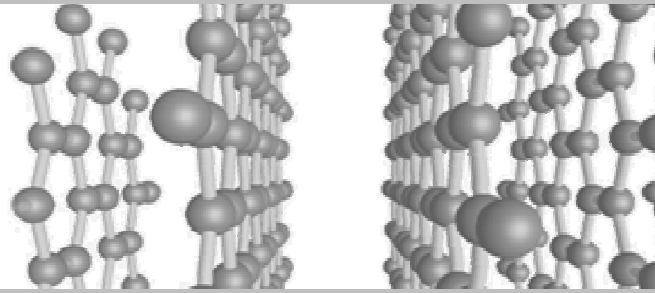


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GRAPHITE COVA GMBH

...OUR CUSTOMERS ARE NUMBER ONE



PRODUCTION OF GRAPHITE ELECTRODES AND RECENT DEVELOPMENT IN THE PRODUCTION OF COATED ELECTRODES

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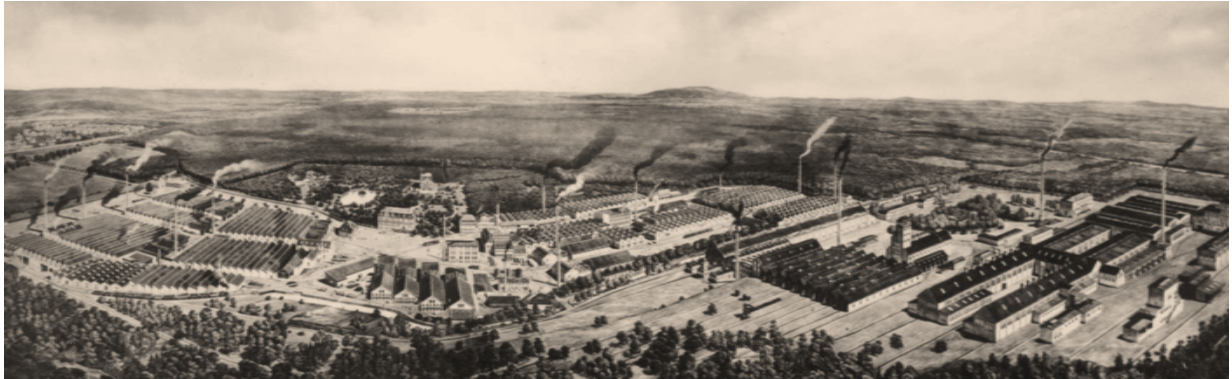
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ABOUT GRAPHITE COVA



ORIGINS

Established in Nuremberg in 1855, the company initially produced pencils, amplifying its range later with arc lamp carbons. In the beginning of the last century, the production was diversified into artificial carbon and electric graphite.



GRAPHITE COVA HISTORY: OUR RÖTHENBACH PLANT WAS BUILT IN RÖTHENBACH IN 1880 ON A SITE OF MORE THAN 450.000 m².

TRADITION

With over 150 years of experience in manufacturing of carbon and graphite products, supplemented periodically with technological upgrades and innovations, graphite Cova ranks among the most respected suppliers of graphite electrodes, speciality carbon and graphite products as well as performance enhancing coating technology for graphite electrodes.

INNOVATION

Today, Graphite Cova is in the technological forefront of the chemicals-industrial sector. While the major part of the overall output is from graphite electrodes, Graphite Cova offers a unique type of coating for graphite electrodes, based on aluminum, graphite and other elements with potential savings in electrode consumption in the range of 15-25%.



GRAPHITE COVA TODAY: HERE IS WHERE "COVA BRAND" GRAPHITE ELECTRODES, COATING FOR GRAPHITE ELECTRODES AS WELL AS SPECIAL CARBON AND GRAPHITE PRODUCTS ARE MANUFACTURED.

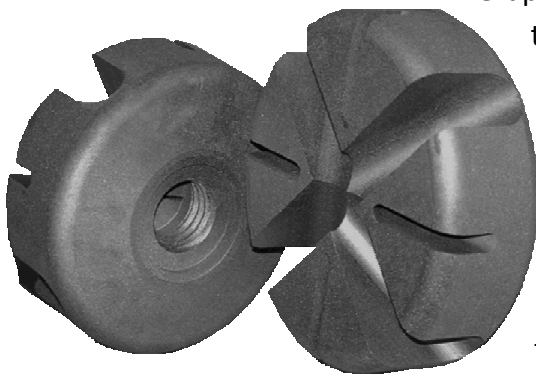
RELIABILITY

Production and sales are planned systematically to ensure timely delivery of good quality products in accordance with customer specifications. The company also extends at site technical services to its customers through its competent team of service engineers. Further strengthened by recent investments in the manufacturing processes as well as environmental protection devices,

Graphite Cova has become a well balanced destination to all its customers with a set of branded products providing total customer satisfaction and earning the reward of brand loyalty.



CUSTOMER ORIENTATION



Graphite Cova offers customer specific technical solutions for applications in various industries, mainly steel, inclusive of other industries, like metallurgical applications, aluminum, non-ferrous covering chemical, glass, telecommunication, automobile industry and also general engineering sectors. With a dedicated technical team of engineers, the company efficiently carries forward its excellent tradition of providing a sound infrastructure and innovative services to its esteemed clientele.

GROUP OF COMPANIES

In August 2004, Graphite Cova became a leading member of the prestigious Graphite India group of companies. In the global ranking of graphite electrode producers, this group features among the top five (5) manufacturers and has established its powerful presence in over 50 countries with a profile of over 150 customers – many of whom are multinationals.

UHP GRAPHITE ELECTRODES



RAW MATERIALS

Graphite features a polycrystalline structure and is based on the production technology related to ceramic materials. Due to its physical and chemical properties, graphite is an excellent electrode material for the use in electric arc furnaces. By choosing specific raw materials and technologies, properties can vary and may be adapted to several factors of influence and operating conditions.

Only a few choice raw materials have the ideal properties for making world-class UHP graphite electrodes.



NEEDLE COKE

*CAREFULLY CRUSHED AND SIEVED
NEEDLE COKE IS THE KEY RAW
MATERIAL USED IN MAKING FIRST
CLASS UHP GRAPHITE ELECTRODES*



PITCH

*A CLASSIC BINDER, PITCH MAKES IT
EASIER TO SHAPE MIXED MATE-
RIALS*



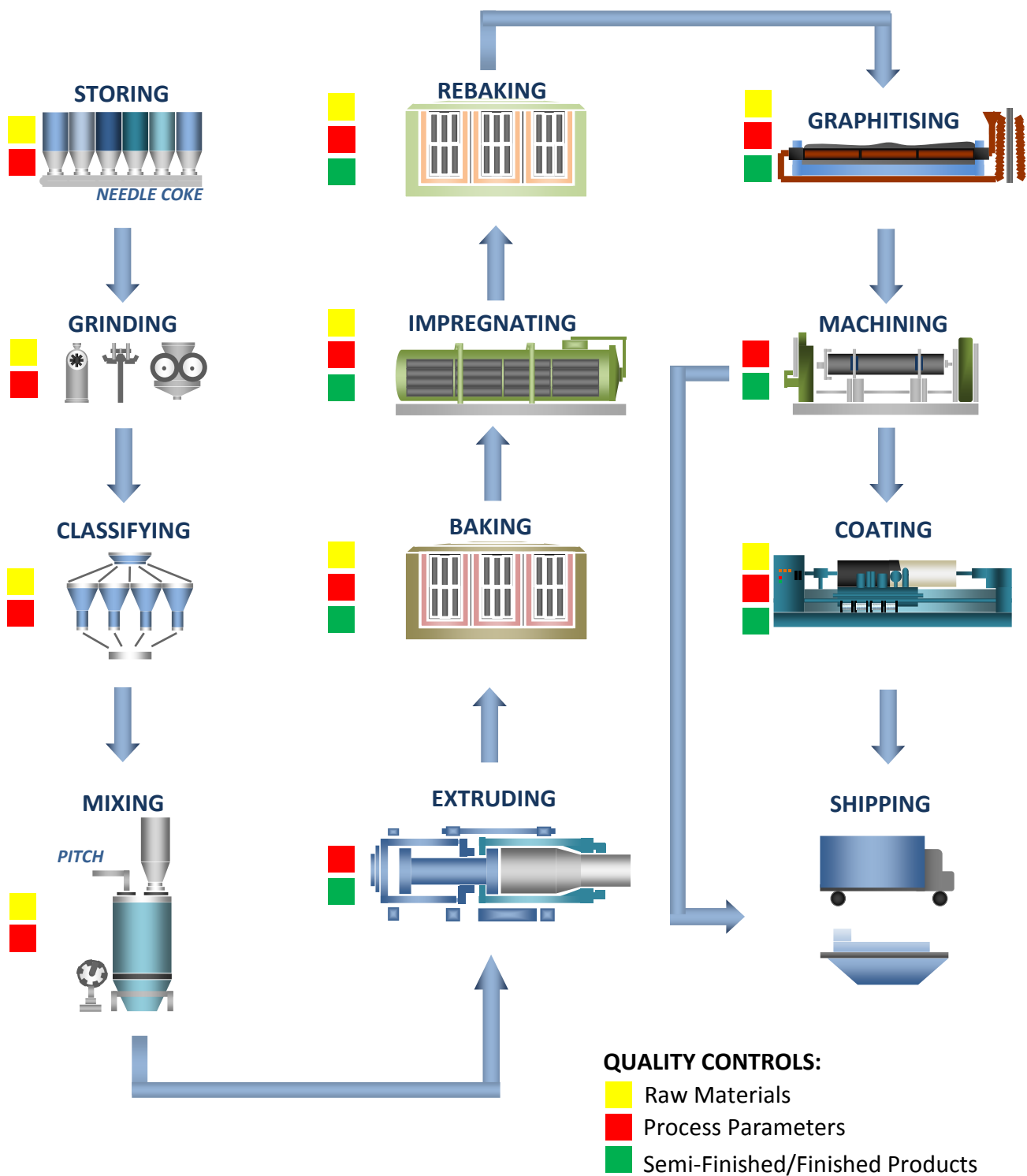
ENERGY

*GREEN BLANKS ARE TRANSFORMED
INTO COMPACT BODIES OF NEARLY
PURE CARBON AT 1000 °C, THEN
FURTHER HEATED TO 3000 °C TO
CREATE ARTIFICIAL GRAPHITE*

PRODUCTION

Up to six months are required to transform the selected raw ingredients into finished products. This metamorphosis is based on years of experience and state-of-the-art expertise.

GRAPHITE COVA - PRODUCTION FLOW



QUALITY

For Graphite Cova, quality has priority. Everything is checked: raw materials, manufacturing processes, final products:

Only a few choice raw materials have the ideal properties for making world-class carbon and graphite products. Graphite Cova's recipe is quality – from beginning to end. First petroleum coke, pitch coke, natural graphite, special coke and tar are carefully selected. Then they are ground, classified, measured and mixed, resulting in an ideal blend for every type of product.

And to make sure things are being done just right, every process is constantly tested, monitored, analysed and controlled. Generations of experience and an innovative spirit help Graphite Cova come up with optimal solutions. Quality assurance guarantees high-purity carbon products in every production step.



QUALITY CONTROL: GRAPHITE COVA TECHNICAL AND CHEMICAL LAB

ELECTRODE QUALITY

The main properties of Cova electrodes and nipples are the following:

- low electrical resistance
- good thermal conductivity
- high resistance to thermal shocks
- good mechanical strength
- high resistance to oxidation
- exact mechanical machining
- manufacturing within narrow tolerances
- safe locking
- low graphite electrode consumption.

Electrodes and nipples are produced according to internal norms derived from the following standards:

- IEC 60239, Fourth edition, 2005-06
- DIN EN 60239, 2006-03
- (in special cases NEMA or JIS).

QUALITY MANAGEMENT

Graphite Cova is certified according to DIN EN ISO 9001 : 2000 :



- Certification for Bavaria Electrodes GmbH is under preparation –
- Energy Management Certification is scheduled for May/June 2009 -

GRAPHITE ELECTRODES CHARACTERISTICS

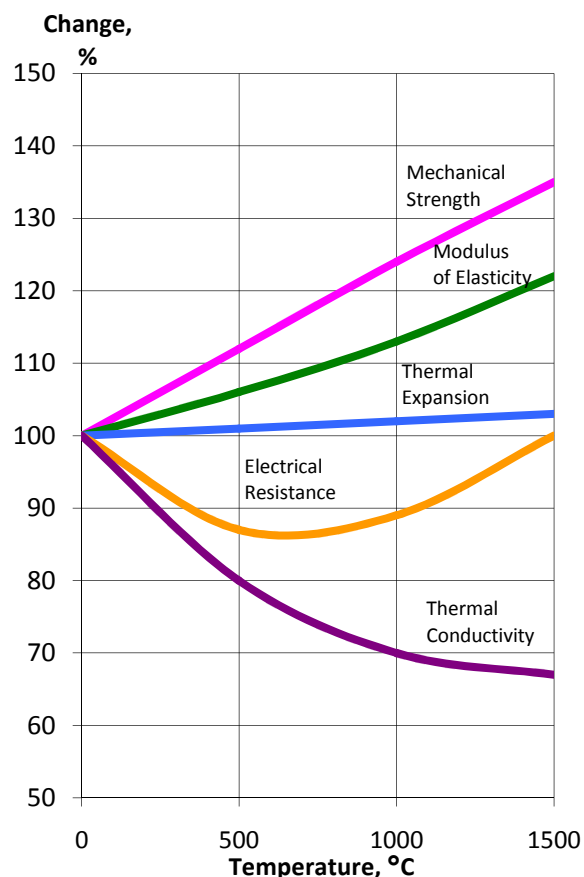
The chart of Typical Properties lists the technological characteristics of our electrodes. The figures are based on room temperature, except where otherwise stated. The average values vary according to the electrode diameter.

High Degree Purity

The high purity of our graphite electrodes is sufficient to meet even most exacting demands of customers.

Resistance to Thermal Shock

In addition to mechanical stress, graphite electrodes also have to withstand high thermal shock. Careful selection of raw materials, their mixing and processing have contributed to a substantial increase in thermal shock resistance, thus greatly improving the stability of the electrodes and eliminating to a great extent the tendency of cracking under high load due to insufficient temperature compensation under the varying operational conditions. The desired shock resistance is attained by favourably balancing the decisive material characteristics such as thermal expansion, thermal conductivity, strength and elasticity.



VARIATION OF THE PHYSICAL CHARACTERISTICS OF ELECTROGRAPHITE WITH TEMPERATURE

Mechanical Strength

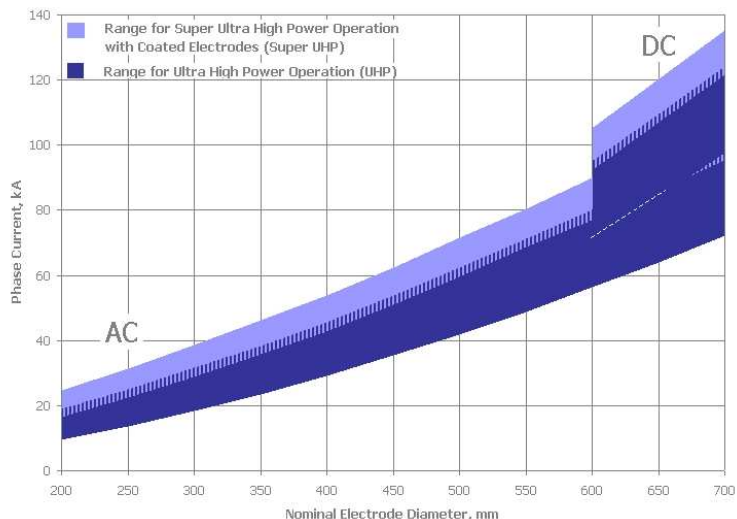
With the exception of extreme cases, the graphite electrodes are capable of withstanding high mechanical stress during the electric arc furnace operation. Mechanical strength attains its maximum when, at higher temperatures, the greatest mechanical stress occurs. Mechanical strength is also of particular importance in connection with the reduction of the electrode tips caused by lateral oxidation.

Electrical Resistance

Low electrical resistance is an important feature of graphite electrodes. Actually this characteristic is essential for coping with the high current densities which electrodes and nipples are subject to in the electric arc furnaces.

CURRENT LOAD

The graphs below show the recommended values of current load on graphite electrodes by different grades and diameters. Operating conditions exceeding the recommended range for the concerned grade may cause increased electrode consumption depending on the individual furnace conditions. Not considering breakage loss for mechanical reasons, the consumption rate of electrodes depends primarily on electrical and thermal loads they are subject to.



Consumption on the electrode tip results from the electrical load transmitted in the arc, whereas lateral consumption (oxidation) is the consequence of thermal load. If, in practice, there is high thermal loading, we recommend operation in the centre band of the electrical load range for electrodes as shown above.

TYPICAL PROPERTIES

Graphite Electrodes Type UHP (COVATM) - Graphite Nipples Type UHP (COVATM – TRIX)

Property	Unit	GRAPHITE ELECTRODES				GRAPHITE NIPPLES	
		Nom. ø 350-500 mm		Nom. ø 550-600 mm			
		min.	max.	min.	max.		
Apparent Density DIN 51 918	[g / cm³]	1,65	1,75	1,65	1,75	1,75	1,86
Resistivity* DIN 51 911	[Ω · μm]	4,6	5,8	4,6	5,8	3,0	4,5
Open Porosity DIN 51 918	[%]	14	22	14	22	8	15
Thermal Conductivity* DIN 51 908 (20°C)	[W / K · m]	160	230	160	230	220	300
Bending Strength* DIN 51 902	[MN / m²]	9	14	9	14	20	30
Young`s modulus* DIN 51 934 / 51 915	[GN / m²]	9	15	9	14	19	28
CTE* (20° - 120° C) DIN 51 909	[10 ⁻⁶ / K]	0,4	1,0	0,4	0,9	0,2	0,9

* measured values of anisotropic properties in longitudinal direction

STANDARD SIZES AND TOLERANCES

DIAMETERS, DIAMETER TOLERANCES AND LENGTHS OF GRAPHITE ELECTRODES

Nominal Diameter mm	Typical Diameter mm	Diameter Tolerances		Nominal Length			
		Max. mm	Min. mm	mm	mm	mm	mm
350	356	358	352	1800	2100		
400	406	409	403	1800	2100	2400	
450	457	460	454	1800	2100	2400	
500	508	511	505	1800	2100	2400	2700
550	559	562	556		2100	2400	2700
600	610	613	607		2100	2400	2700

Note: special diameters and/or length on request

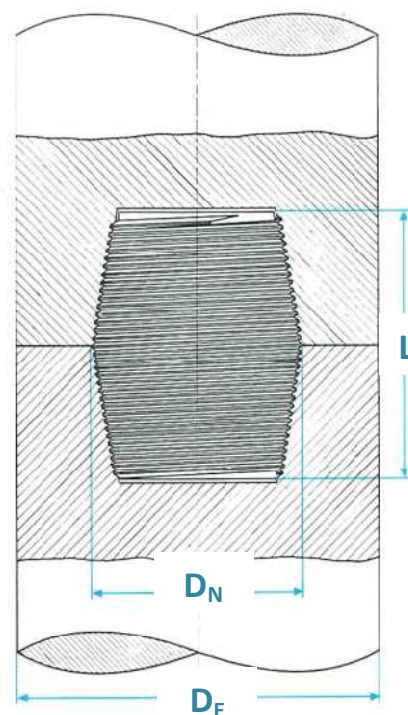
LENGTH TOLERANCES OF GRAPHITE ELECTRODES

Nominal Length mm	Tolerances for Length	
	mm	mm
1800	100	-100
2100	125	-125
2400	125	-125
2700	200	-150

Note: the acceptable percentage of short-length electrodes per delivery is decided by agreement between supplier and user

DIMENSIONS OF GRAPHITE NIPPLES (TYPE T4N AND T4L)

Nominal Diameter of Electrode D_E mm	Nipple Type	Length L mm	Outside Diameter of Nipple D_N mm
350	N 203 T4 N	254,00	203,20
400	N 222 T4 N	304,80	222,25
400	N 222 T4 L	355,60	222,25
450	N 241 T4 N	304,80	241,30
450	N 241 T4 L	355,60	241,30
500	N 269 T4 N	355,60	269,88
500	N 269 T4 L	457,20	269,88
550	N 298 T4 N	355,60	298,45
550	N 298 T4 L	457,20	298,45
600	N 317 T4 N	355,60	317,50
600	N 317 T4 L	457,20	317,50



TAPER NIPPLE FOR GRAPHITE ELECTRODES:
MAIN DIMENSIONS

SUPER UHP ELECTRODES

COATING FOR GRAPHITE ELECTRODES

WE DIDN'T INVENT THE GRAPHITE ELECTRODE...



... BUT WE KNOW HOW TO MAKE IT BETTER!

Throughout the world, Graphite COVA is the only producer and supplier of protective coating for graphite electrodes. This sophisticated product gives excellent antioxidation properties to graphite electrodes and reduces the specific graphite consumption considerably. Coated electrodes are used for the production of electric steel as well as for manufacturing non-metallic products in electric arc processing.



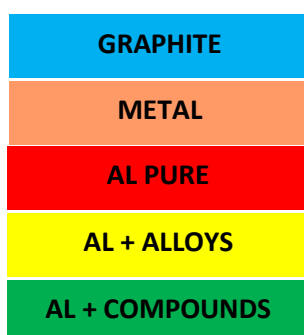
The protective coating consists of several layers and is applied to the electrode surface in a complicated, multilevel production process. A special characteristic of the coating technology is the electric arc treatment of every single layer. The latest patent dates from the year 2000.

Depending on the specific operation conditions of the arc furnace, different types of coating are offered (black or white).

PROPERTIES

TECHNICAL PARAMETERS AND STRUCTURE

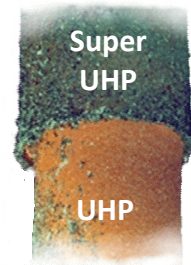
Parameter	Unit	Value
Thickness of the Coating	mm	0,5 – 0,8
Specific Electrical Resistivity	$\Omega \cdot \mu\text{m}$	0,07 – 0,10
Gas Impermeability at 900 °C	h	above 50
Temperature when Decomposition Process starts	°C	above 1850
Delay of Graphite Surface Oxidation	h	10 – 20



ADVANTAGES

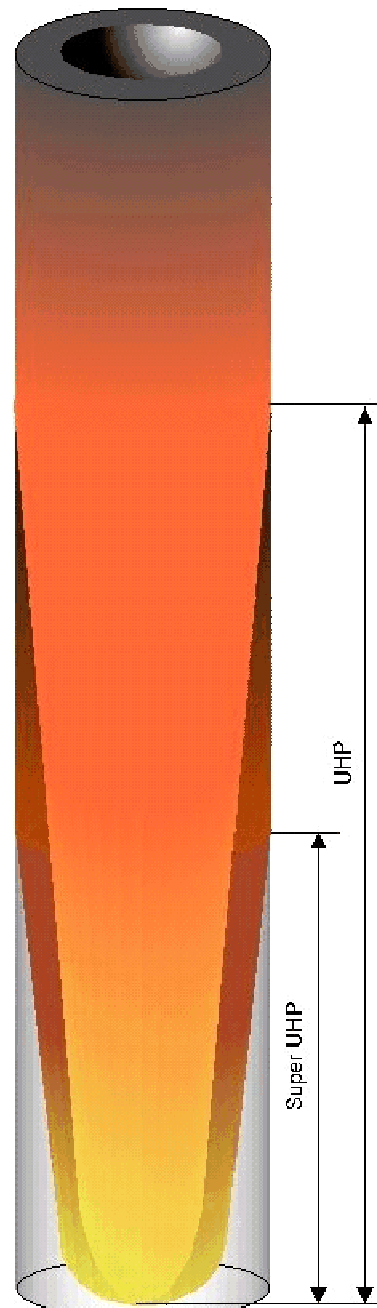
➤ **reduction of the specific graphite consumption of up to 25%**

- ➔ reduced side oxidation
 - reduced oxidation cone
 - increased tip diameter
- ➔ reduced tip consumption
 - reduced number of electrode connections
 - reduced tip losses



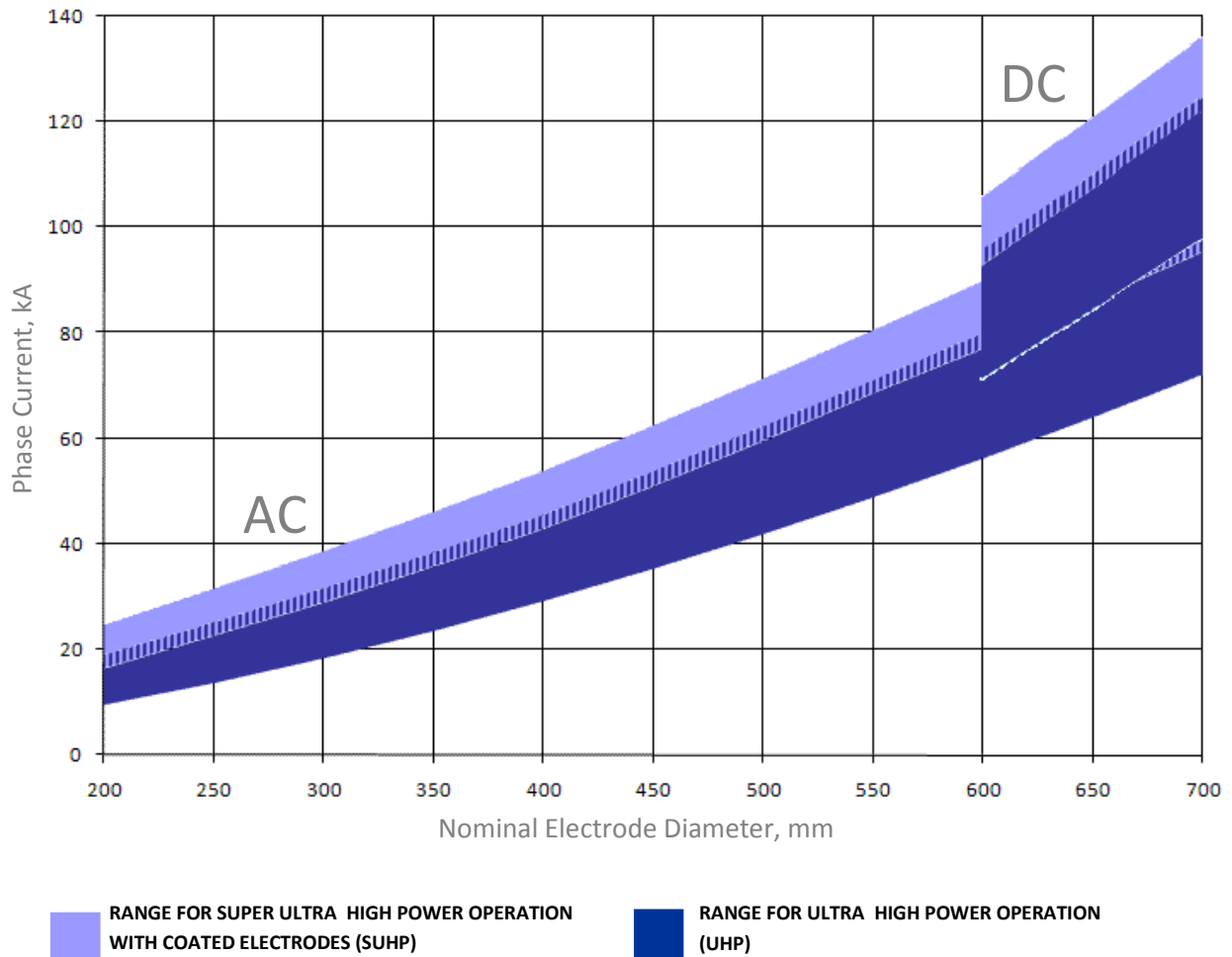
➤ **improved conductivity of the electrodes**

- ➔ by use of high conductive aluminum
- ➔ by redistribution of the electrical current flow



➤ **increased current carrying capacity of the electrodes**

- ➔ by relieving the electrical strain to the electrode centre and nipples
- ➔ by increasing the electrical conductivity by 20–25%



➤ **time saving**

- ➔ reduced number of electrode connections
 - improved working conditions for furnace staff
 - reduced crane times