Ultra-High-Performance Graphite Electrodes
Graphite Electrodes – made by SDK.

- Customized solutions for a wide variety of applications
- Consistent high quality
- Value-added services based on Six Sigma methodology
- Manufacturing facilities in North America, Europe and Asia
- Global service network with short response times
- More than 100 years of graphite electrode manufacturing experience

We are partners to our customers.
High product quality and service leads to maximized customer value!

SDK is one of the leading graphite electrode producers worldwide and a reliable partner of the steel industry. Product portfolio, quality and service approach qualify our graphite electrodes for all steel and non-steel applications.

Our local production on three continents ensures a short supply chain to all customers worldwide. This allows for reduced inventories at customers' sites and an increased flexibility that is essential in times of volatile demand.

Consistent product performance is assured by defining global manufacturing standards for graphite electrodes. In addition, standardization helps to improve the quality of the product on a continuous basis since internal benchmarks can be used between the various facilities. SDK Excellence supports continuous improvement of products and processes by using Six Sigma and Lean as core tools.

More than 100 years of experience in producing graphite electrodes and a global sales and service network with offices in more than 40 countries enable SDK to be the electrode supplier with the highest service level in the industry in terms of product availability and technical support.

We provide technical service for electrode use – and more. SDK’s service portfolio consists of various tools, ranging from electrical measurements up to the general melting process optimization in joint teams between customer and SDK. The main goals of all service tools are increased melt shop performance and reducing total costs – starting with the delivery of the graphite electrodes through to the consumption of the graphite electrodes in the furnace
Graphite electrodes – made by SDK.

Individual solutions for electric and submerged arc furnaces.

Iron ore based steel making

Non steel applications

Scrap based steel making

Secondary steel making

Graphite electrodes

Graphite electrodes
Graphite electrodes from SDK –

SDK’s high quality graphite electrodes are always customers first choice in the electric steel production.

SDK has extensive process and product expertise as well as state-of-the-art production equipment and procedures. This guarantees the consistent high quality of our products and is the basis for solutions which contribute to our customers’ productivity increase. Graphite electrodes and connecting pins are machined according to internal standards (derived from international standards IEC60239, JIS, NEMA).

We continuously refine our products in line with the challenges and improvements in the steel and smelting industry. This yields many benefits for our customers:
- Bigger electrode diameters, allowing higher current loads to be used
- Optimized processes based on finite element modelling and consistency awareness based on statistical process control
- Practice-proven electrode and connecting pin designs through close cooperation with leading furnace manufacturers

The stable and high performance of our electrodes is the result of consistent material properties:
- Heat resistance
- Electrical conductivity
- Resistance to thermal shock
- Low chemical reactivity

**Typical properties of graphite electrodes**

<table>
<thead>
<tr>
<th>Graphite electrodes</th>
<th>Units</th>
<th>SIGRA-LF</th>
<th>MELT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter</td>
<td>mm</td>
<td>350-450</td>
<td>350-450</td>
</tr>
<tr>
<td></td>
<td>in</td>
<td>14-18</td>
<td>14-18</td>
</tr>
<tr>
<td>Apparent density</td>
<td>g/cm³</td>
<td>1.63-1.72</td>
<td>1.66-1.76</td>
</tr>
<tr>
<td>Specific electrical resistance</td>
<td>µΩm</td>
<td>4.9-7.5</td>
<td>4.9-5.7</td>
</tr>
<tr>
<td>Flexural strength</td>
<td>MPa</td>
<td>9-15</td>
<td>8-13</td>
</tr>
<tr>
<td>Thermal conductivity</td>
<td>W/(K·m)</td>
<td>160-210</td>
<td>220-270</td>
</tr>
<tr>
<td>Thermal expansion</td>
<td>µm/(K·m)</td>
<td>0.7-1.8</td>
<td>0.3-0.7</td>
</tr>
</tbody>
</table>

All values measured parallel to extrusion direction. Graphite electrodes from SDK are produced with a high degree of purity so as to have no adverse effect on the refining of steel.
Graphite electrodes

SDK has established a new size standard by introducing the world’s first graphite electrode with a diameter of 800 mm (32”). We provide graphite electrodes with diameters from 350 to 800 mm (14” to 32”) and lengths up to 3600 mm (142”). The use of state-of-the-art equipment and advanced measuring instruments and methods ensure compliance with product tolerances in accordance with international standards. We also manufacture graphite electrodes according to customer-specific requests.

### Diameter tolerances

<table>
<thead>
<tr>
<th>Nominal diameter</th>
<th>Lower range</th>
<th>Full tolerance</th>
<th>Upper range</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>min. mm</td>
<td>max. mm</td>
<td>min. mm</td>
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<tr>
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</tr>
<tr>
<td>800</td>
<td>810</td>
<td>812</td>
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</tr>
</tbody>
</table>

### Length tolerances

<table>
<thead>
<tr>
<th>Nominal length</th>
<th>Lower range</th>
<th>Full tolerance</th>
<th>Upper range</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>min. mm</td>
<td>max. mm</td>
<td>min. mm</td>
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<tr>
<td>1500</td>
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<td>1510</td>
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<td>1689</td>
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<tr>
<td>3600</td>
<td>3451</td>
<td>3595</td>
<td>3596</td>
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</table>
Connecting pins

SDK offers a broad spectrum of connecting pins coming with slots and fixing plugs as standard features. For electrode diameters from 350 to 800 mm (14" to 32"), we supply standard connecting pins with 4 threads per inch. Connecting pins with 3 threads per inch are available for electrode diameters from 350 to 550 mm (14" to 22") upon customer requirement.

Connecting pin tolerances T4

<table>
<thead>
<tr>
<th>Electrode nominal diameter</th>
<th>Pin Diameter</th>
<th>Pin length</th>
<th>Type</th>
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<tbody>
<tr>
<td>mm</td>
<td>in</td>
<td>mm</td>
<td>in</td>
</tr>
<tr>
<td>350</td>
<td>14</td>
<td>203.20</td>
<td>8.00</td>
</tr>
<tr>
<td>400</td>
<td>16</td>
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<td>18</td>
<td>241.30</td>
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<td>10.63</td>
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<td>22</td>
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<td>600</td>
<td>24</td>
<td>327.50</td>
<td>12.50</td>
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<td>26</td>
<td>355.60</td>
<td>14.00</td>
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<tr>
<td>700</td>
<td>28</td>
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<td>750</td>
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<tr>
<td>800</td>
<td>32</td>
<td>431.80</td>
<td>17.00</td>
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</table>

Recommended joining torque

<table>
<thead>
<tr>
<th>Electrode diameter</th>
<th>Torque</th>
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<tbody>
<tr>
<td>mm</td>
<td>in</td>
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<tr>
<td>350</td>
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<td>16</td>
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<tr>
<td>750</td>
<td>30</td>
</tr>
<tr>
<td>800</td>
<td>32</td>
</tr>
</tbody>
</table>

Mechanical joining procedure

A sufficiently high and well-defined torque is essential to ensure the proper performance of the graphite electrode joint. For diameters exceeding 450 mm (18"), mechanical joining with torque control by a hydraulic assembly station or robot joining is highly recommended.
Sales and Distribution

We operate globally and are always close to our customers. We ensure short and secure routes with worldwide production facilities, combined with intelligent logistics and transport solutions:

- Production sites on three continents
- Global sales network
- Highly qualified sales and technical expert
- Fully integrated supply chain
- Special packaging for safe transport
SDK’s Graphite Electrodes Sales and Distribution –

**SDK’s Graphite Electrodes sales and distribution operations are global, efficient, reliable and above all customer oriented!**

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**Pins after machining**

**Graphite electrodes after machining operation**

**SDK supplies the steel industry all over the world.** We cover the international demand for ultra-high-performance electrodes with our global structures and regional presence: Production sites in Europe, America and Asia ensure short ways and close contact.

Competent and pro-active customer service by our order management team supports our customers from sales offices on five continents. SDK's regional sales teams are well-versed in market-specific circumstances and offer prompt solutions to meet your needs together with our cooperative partners.

Supply-chain management and streamlined organization structures guarantee quick and smooth processes.

We focus on integrated processes – from purchasing the raw materials to shipping the finished products. These ensure a controlled flow of information and consistent data – an ideal basis for effective cooperation between order management, production planning and logistics. They also guarantee short delivery times and products manufactured exactly according to the customer's requirements.

Our graphite electrodes arrive at their destination safely in packages designed specifically for the individual transport. We have developed special packaging solutions for each transportation route. They both offer maximum cargo protection and also simplify package handling all the way to the customer's warehouse.
Optimization partner for EAF operators

Thanks to perfect teamwork between SDK and one of our customers, an SDK ECO PRO project made it to completion in just 6 months: reduction of electric energy by 3 %, electrode consumption by 6 %, and heating time by 5 %.

This was the result of optimizing technical and electrical operating parameter as well as adjustments made to the furnace maintenance process based on extensive analyses.

This is just one example of an application-specific optimized solution from SDK.
Competence

We are familiar with all electric arc furnace applications worldwide and support steel plants with our global network of experts. We combine our experience in material science with metallurgy and electrical engineering to actively assist our customers in taking full advantage of their application potentials, developing new ideas and implementing them successfully.

Our service competences:

- Graphite electrodes
- EAF applications
- Melting processes
- Six Sigma supported project work
Service makes the difference.

SDK’s services are tailored to the situation and requirements of each individual customer and extend far beyond “standard” product services.

Several examples from our range of services:
- Product monitoring
- Performance analysis
- Inventory control
- Electrical measurements
- Inspection of accessories
- Monitoring of electric arc furnaces
- Customized reporting
- Tailor-made data analysis
- Regulator optimization

We develop joint projects with our customers for reducing the total cost of ownership (TCO). We provide our customers with long-term assistance to ensure continuous process improvement. This enables us to provide support in establishing process standards which offer high saving potentials. Our service specialists take active part in projects to achieve the defined goals by using the Six-Sigma methodology and a structured project management.
Service far beyond the electrode.

Our exclusive range of services has an offer for any problems

Monitoring and improvement detection
We offer on-site, off-site and online solutions to monitor process parameters. We gather the EAF operating and control data for remote monitoring from the customer’s PLC provided specific consent has been received. Strict compliance with all confidentiality obligations goes without saying. We provide the results in the form of complete analyses and reports prepared so as to be easily intelligible in the customer’s preferred format. All of the data is also evaluated by our experts, in order to identify process optimization potentials and provide recommendations for optimization.

Electrical measurements for process analysis and diagnosis
We conduct electrical measurements on our customers’ electric arc furnaces. This makes process details easier to understand and electrical weak points easier to detect. The measurement results allow us to deduce recommended actions and optimize settings in consideration of the following aspects:

- Electrical balance (refractory wear issues)
- Melting profile
- Current level (long/short arc strategy)
- Foamy slag judgment
- Arc stability problems
- Productivity
- Melting efficiency
- Electrode consumption mechanism
- Electrode regulation dynamics
Optimization and troubleshooting by EAF experts with special tools

SDK’s optimization specialists are intimately familiar with steel production and have a comprehensive set of instruments for analyzing existing processes. They offer our customers tailor-made solutions carried out in joint teams. Analytical and statistical procedures are used to detect deviations and inefficiencies in the electric arc furnace’s melting process. The use of special tools ensures that all actions are heading in the right direction and provide credible results. Examples of our optimization services include:

- Consumption models (comparison of theoretical and actual consumption)
- Validation of increases in productivity
- Recommendations on furnace design and operation
- Assistance in commissioning the furnace
- Electricity use modification
- Control and hydraulic optimization
- Melting profile depiction
- Benchmarking (comparative process and result analysis)

ECO PRO

ECO PRO stands for EAF Control Optimization and professional cooperation. Under SDK ECO PRO, we form special partnerships with our prime customers to gain better results. Highly qualified and experienced SDK personnel employ Six Sigma techniques along with the customer’s own experience to find solutions applicable to the unique situation of the particular customer. We believe that cooperation has only been successful if our customer is totally satisfied with the improvements achieved on completion of the project.

SDK ECO PRO partnerships cover not only electrodes but also everything around the EAF process. Successful cooperation carried out so far have related to topics such as:

- Higher efficiency
- Power and Process Profiles
- Lower energy consumption
- Productivity increases
- Carbon / oxygen injection
- Chemical energy optimization
- Customer cost reduction

Electrode care and handling

Graphite electrodes and jointing equipment are very sensitive. All of these components require correct use and proper handling to ensure best results in the melting process. We assist our customers in this regard with the following services:

- Accessory handling training
- Equipment integrity check
- Jointing improvement
- Training and workshops
- Support on all EAF-relevant improvement questions
We’ll find the right solutions – together

Based on our passion and commitment to our customers we constantly increase the quality level of our graphite electrodes and services.

Thanks to our long-standing experience in manufacturing of graphite electrodes and our international presence, we are able to achieve high service levels and maintain close, partner-like relationships with customers worldwide. Total cost of ownership is more than just marketing to us, it’s our mindset of doing business.

We’ll work together to identify the right solutions for your specific application based on your individual needs and objectives.
Graphite Electrodes

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