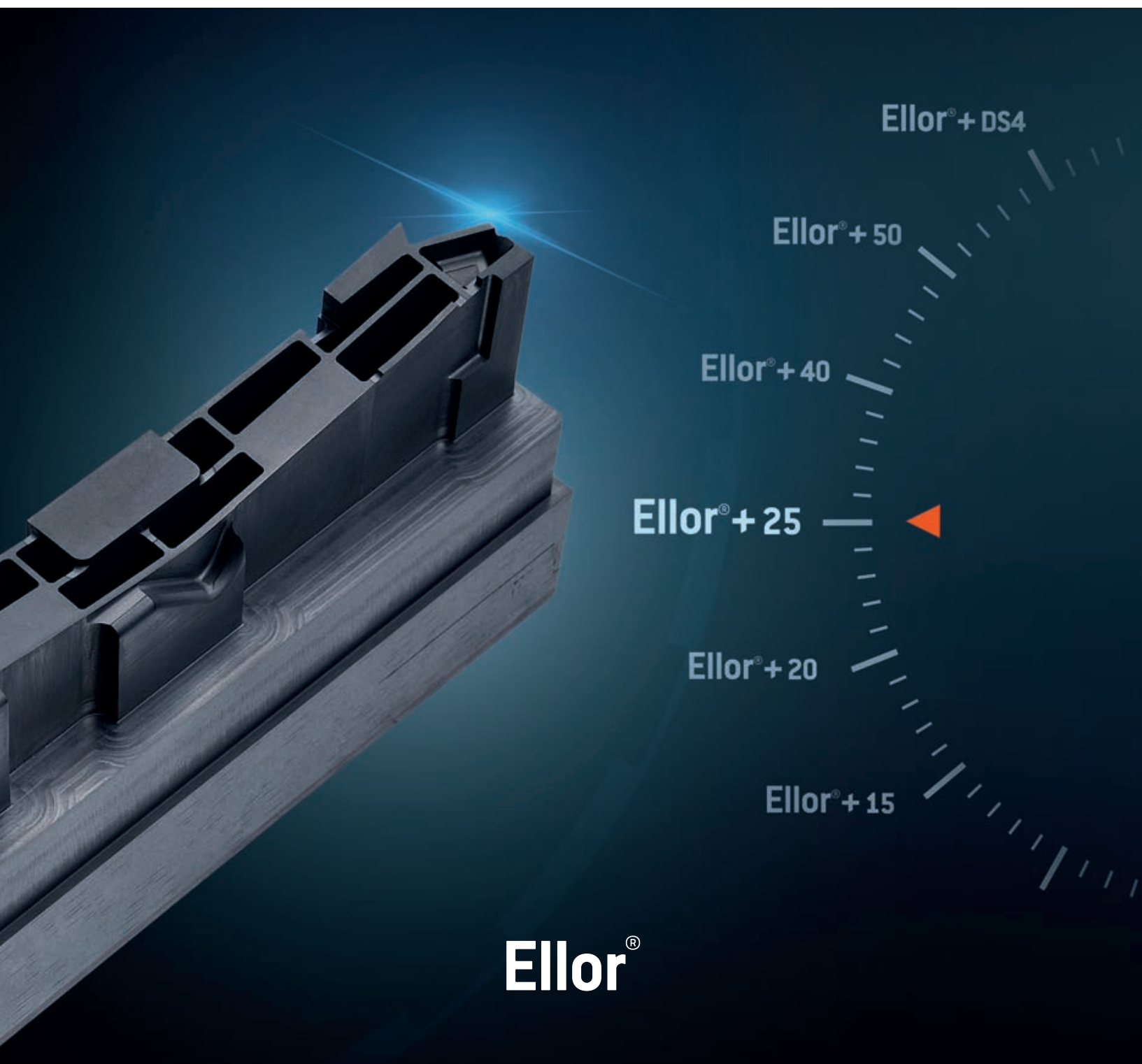


GRAPHITE GRADES  
FOR ELECTRICAL  
DISCHARGE MACHINING  
(EDM)





# It's all about the right balance

With its leading experience in EDM, Mersen has developed a complete range of graphite grades aiming to answer to the widest range of electrode designs and workpiece materials.

The selection of the right graphite grades will depend on numerous factors. Mersen's expertise will guide you to the proper conclusion. There are 4 key factors that will largely impact your selection.



## WEAR RESISTANCE

**Or how long will the electrode be able to maintain the level of details during the spark erosion process?**

A good Wear Resistance control of your graphite electrode means fewer electrodes to do the same job, less time and decreased manufacturing cost.

Low graphite wear will determine the accuracy of the work. The material loss is more significant with coarse grain graphites since the amount of wear will be greater than with fine grain graphite at the same operating parameters.



## METAL REMOVAL RATE

**Or how fast will the graphite electrode remove material during the spark erosion process?**

Typically the larger the grain of the electrode graphite, the higher the Metal Removal Rate.

Typically, with each spark, a fine grain graphite grade will remove less metal on the work piece than a coarse grain graphite but will have a smoother surface finish.

# GRAPHITE VS COPPER

## Easy to machine

it is much easier to fabricate an electrode out of graphite than copper

## 5 times lighter

graphite has a low density so electrodes weigh less. This is a critical factor as electrodes become larger

## Greater geometrical stability

due to its low Coefficient of Thermal Expansion graphite will not expand as much as copper, allowing it to maintain its critical dimensions

## Metal Removal Rate is doubled

graphite has a metal removal rate 2 times higher than copper with lower electrode wear

## Much less Wear

graphite does not melt but sublimates at 3,400° C, providing much greater wear resistance than the low melting point of copper

DISCOVER OUR SOLUTIONS ►



**SURFACE FINISH**

**Or how smooth should your workpiece surface be?**

Fine grain graphite grades will be the preferred choice to erode very fine and smooth surfaces up to 0,4 Ra(μm). The greatest advantages are when complicated cavities are involved. Such cavities are difficult, time consuming and therefore expensive to polish manually.

When a very high quality finish is needed, the operator follows a high-speed roughing cut with one or more finishing – skimming, to use EDM terminology – cuts. By taking multiple skimming passes, EDM finish quality can become almost mirror-like.



**MACHINABILITY**

**Or how easy the material can be machined into fine details with good finish?**

Graphite grades are not equal when it comes to machining them into electrodes. Ultra-fine particle sizes are key to achieve a perfect accuracy of the electrode. Time to produce an electrode is highly related to:

- > the grain size of the grade
- > its strength along with the complexity of the electrode to be machined.



# 01

## UNIVERSAL FINE GRAIN GRADE

For high metal removal  
rate with excellent  
performance ratio

Ellor® +15  
Ellor® +20

### YOUR BENEFITS:

- Production cycles shortened with high removal rate capacities
- Excellent machinability
- Best choice for medium surface finish
- Ellor® +15 recommended for die casting molds in aluminium

#### WEAR RESISTANCE

3/5

#### METAL REMOVAL RATE

5/5

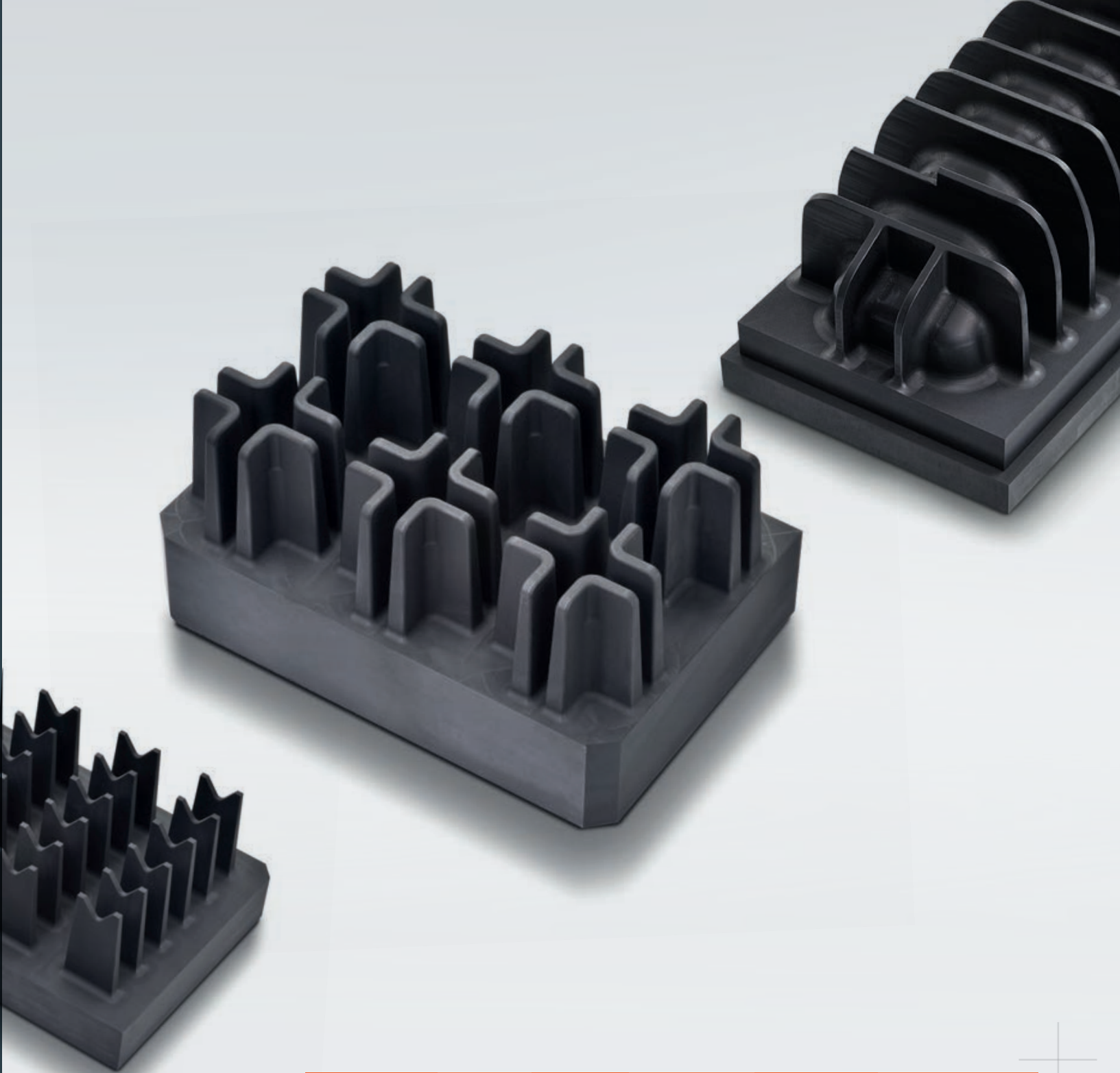
#### SURFACE FINISH

3/5

#### MACHINABILITY

4/5





GRAIN SIZE		HARDNESS SHORE	HARDNESS ROCKWELL	DENSITY		FLEXURAL STRENGTH		ELECTRICAL RESISTIVITY	
$\mu\text{m}$	inch			$\text{g}/\text{cm}^3$	$\text{lbs}/\text{ft}^3$	MPa	psi	$\mu\text{ohm}\cdot\text{cm}$	$\text{ohm}\cdot\text{inch}$

**Ellor<sup>®</sup>+ 15**

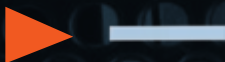
12	0.0005	62	98 L	1,78	111	45	6,500	1370	0.00054
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**Ellor<sup>®</sup>+ 20**

11	0.0005	65	72 H	1,81	112	52	7,500	1240	0.00049
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Ellor<sup>®</sup> + 25



02

## UNIVERSAL SUPERFINE GRAIN GRADE

### YOUR BENEFITS:

- Good removal rate capabilities
- Superior strength and wear resistance characteristics for longer life time
- Easy to machine
- Excellent surface finish up to 1,6 Ra(μm)

WEAR RESISTANCE

4/5

METAL REMOVAL RATE

4,5/5

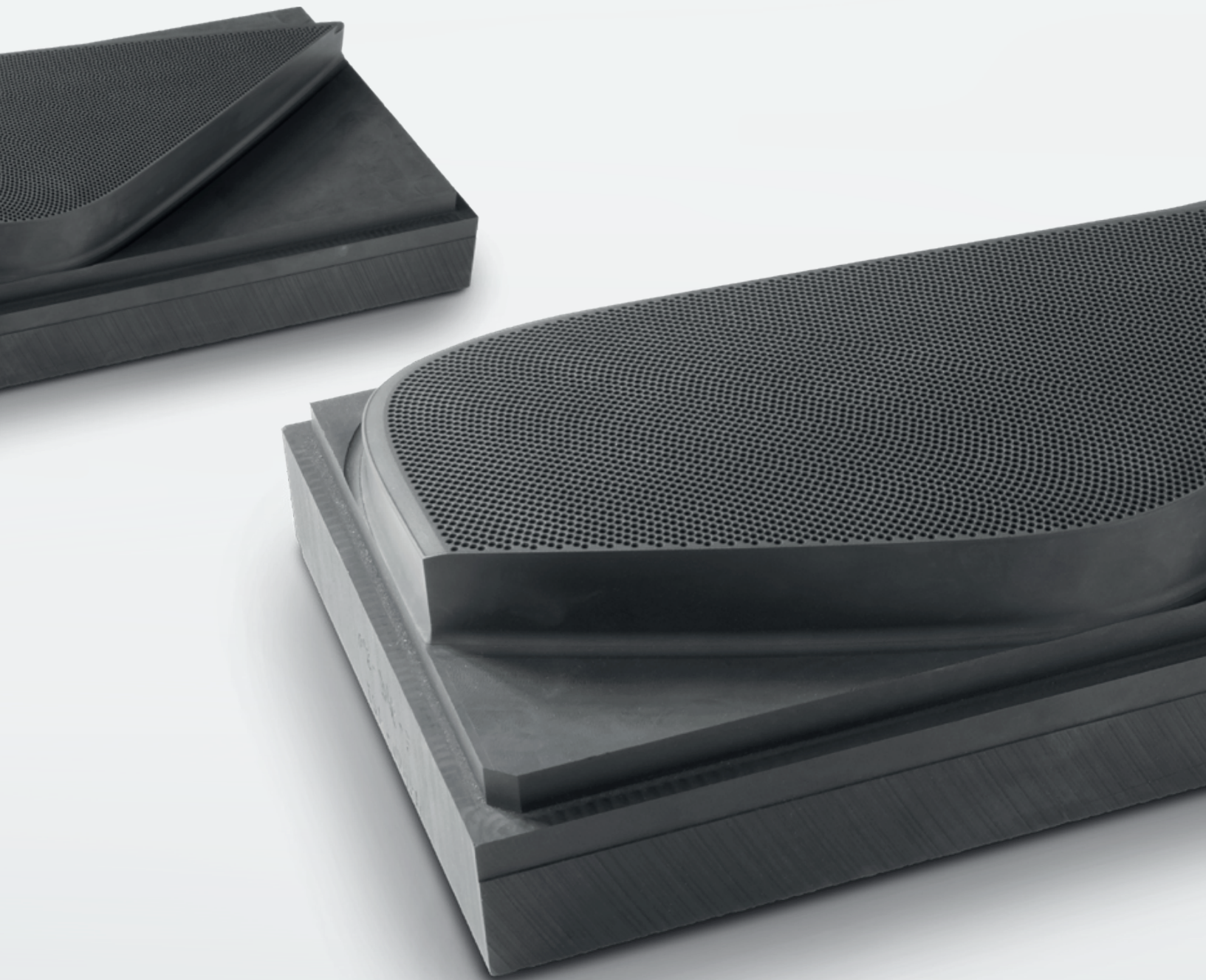
SURFACE FINISH

4/5

MACHINABILITY

4,5/5





GRAIN SIZE		HARDNESS SHORE	HARDNESS ROCKWELL	DENSITY		FLEXURAL STRENGTH		ELECTRICAL RESISTIVITY	
μm	inch			g/cm <sup>3</sup>	lbs/ft <sup>3</sup>	MPa	psi	μohm.cm	ohm.inch

**Ellor® + 25**

9	0.0004	65	80 H	1,83	114	55	8,000	1220	0.00048
---	--------	----	------	------	-----	----	-------	------	---------

ELLOR® + 25 also exists in copper impregnated graphite grade for a higher electrical conductivity and improved performance

# 03

## EXCEPTIONAL SUPERFINE GRAIN GRADES

for outstanding  
performances

### YOUR BENEFITS:

- Exceptional surface finish up to 0,56 Ra(µm)
- Outstanding strength and wear resistance to keep a high performance even with intricate designs
- Excellent Metal Removal Rate (MRR)
- Preferred grades from mobile phone manufacturers

Ellor<sup>®</sup> + 40

Ellor<sup>®</sup> + 50



Ellor<sup>®</sup> + 40

WEAR RESISTANCE

4,5/5

METAL REMOVAL RATE

4,5/5

SURFACE FINISH

4,5/5

MACHINABILITY

4,5/5

Ellor<sup>®</sup> + 50

WEAR RESISTANCE

5/5

METAL REMOVAL RATE

4,5/5

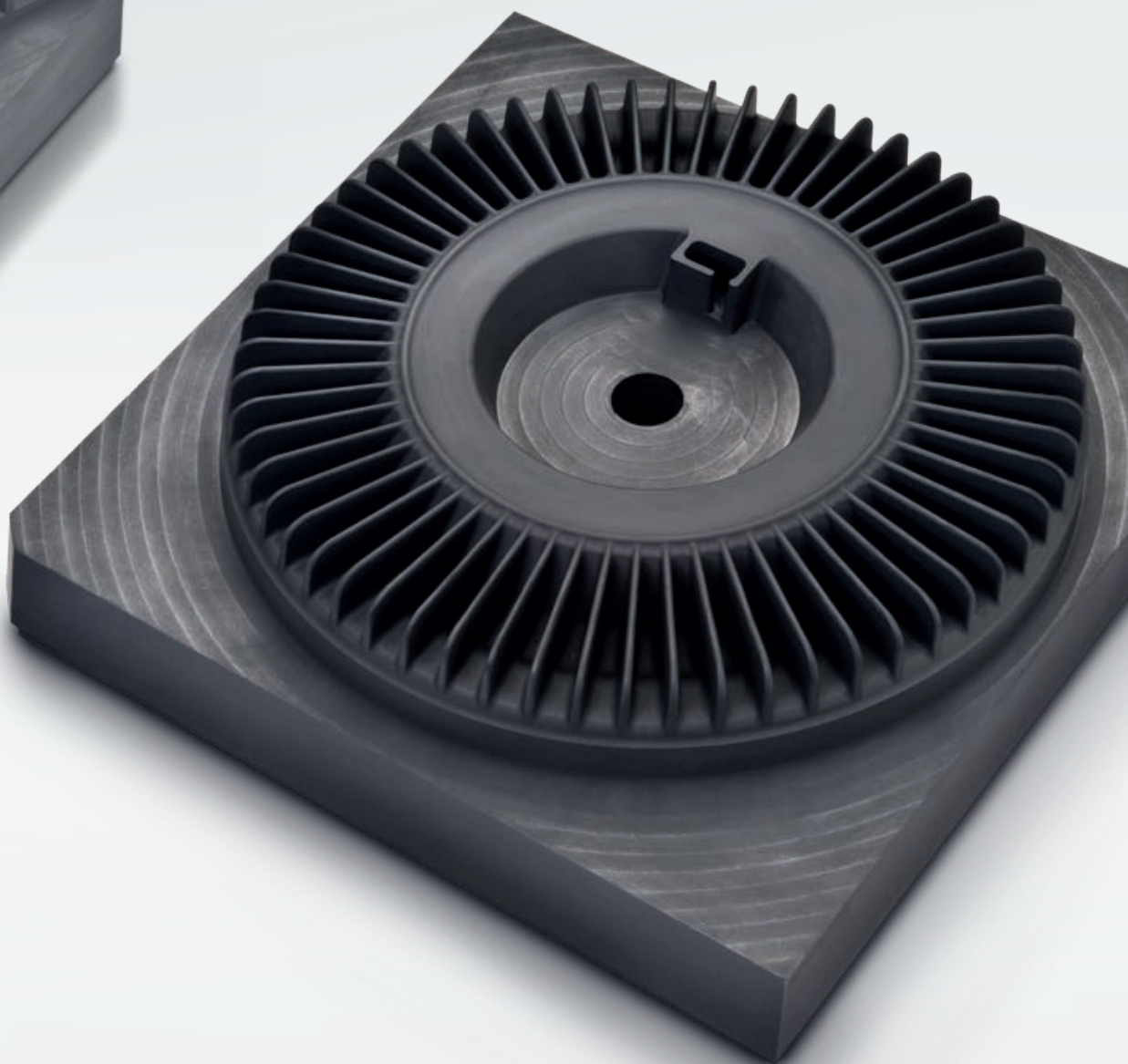
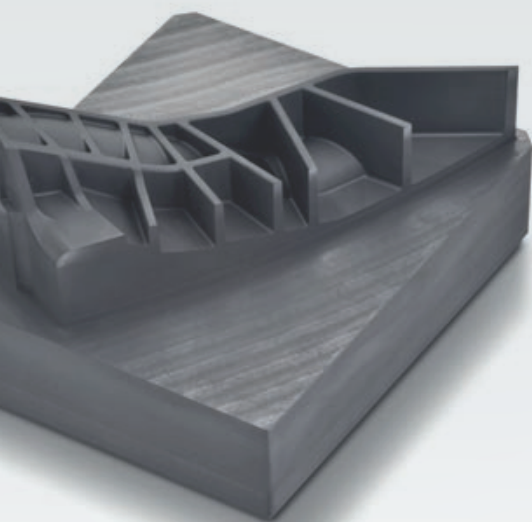
SURFACE FINISH

5/5

MACHINABILITY

3,5/5





GRAIN SIZE		HARDNESS SHORE	HARDNESS ROCKWELL	DENSITY		FLEXURAL STRENGTH		ELECTRICAL RESISTIVITY	
$\mu\text{m}$	inch			$\text{g}/\text{cm}^3$	$\text{lbs}/\text{ft}^3$	MPa	psi	$\mu\text{ohm}\cdot\text{cm}$	$\text{ohm}\cdot\text{inch}$

**Ellor<sup>®</sup> + 40**

7	0.0003	60	75 H	1,78	111	60	8,700	1270	0.00050
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**Ellor<sup>®</sup> + 50**

5	0.0002	80	95 H	1,86	116	76	11,000	1370	0.00054
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Ellor<sup>®</sup> + DS4



04

## THE PREMIUM ULTRAFINE GRAIN GRAPHITE

### YOUR BENEFITS:

- Exceptional surface finish up to 0,40 Ra(μm)
- Outstanding strength and wear resistance to keep a high performance even with intricate designs

WEAR RESISTANCE

5/5

METAL REMOVAL RATE

5/5

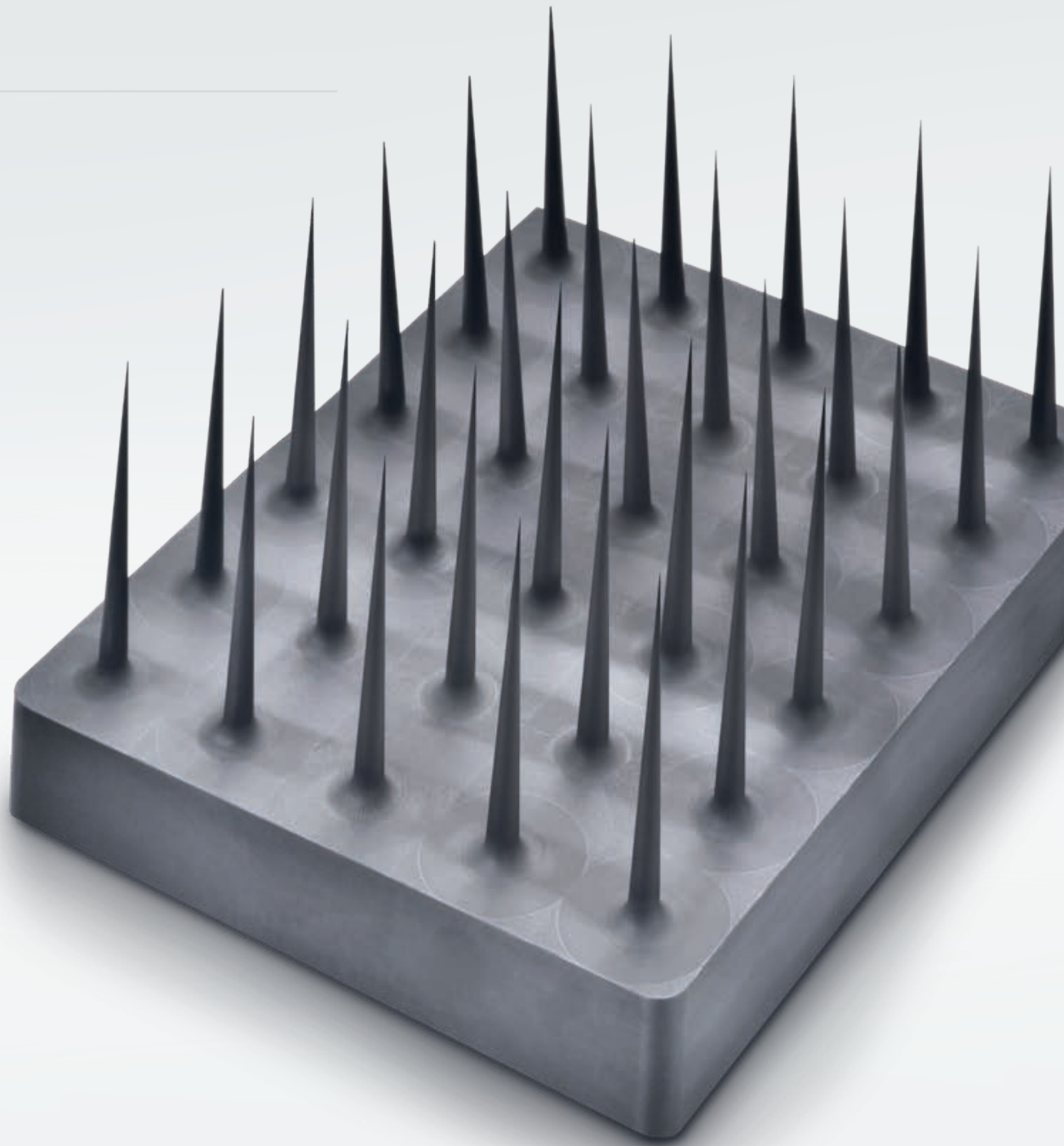
SURFACE FINISH

5/5

MACHINABILITY

5/5





	GRAIN SIZE		HARDNESS SHORE	HARDNESS ROCKWELL	DENSITY		FLEXURAL STRENGTH		ELECTRICAL RESISTIVITY	
	μm	inch			g/cm <sup>3</sup>	lbs/ft <sup>3</sup>	MPa	psi	μohm.cm	ohm.inch
<b>Ellor<sup>®</sup> + DS4</b>	4	0.0002	72	95 H	1,88	117	90	13,000	1270	0.00050
<b>Ellor<sup>®</sup> + DS4C</b>	4	<0.0002	75	110 H	3,00	187	131	19,000	381	0.00015




































# A COMPLETE OFFERING OF EDM GRADES TO COVER ALL YOUR NEEDS

	AVERAGE GRAIN SIZE		DENSITY		HARDNESS ROCKWELL	HARDNESS SHORE	FLEXURAL STRENGTH		ELECTRICAL RESISTIVITY		MAXIMUM BLOCK SIZES	
	μm	inch	g/cm <sup>3</sup>	lbs/ft <sup>3</sup>			MPa	psi	μohm.cm	ohm.inch	mm	inch
<b>Ellor<sup>®</sup> + 15</b>	12	0.0005	1,78	111	98 L	62	45	6,500	1370	0.00054	305x610x2030	12x24x80
<b>Ellor<sup>®</sup> + 20</b>	11	0.0005	1,81	112	72 L	65	52	7,500	1240	0.00049	305x610x2030	12x24x80
<b>Ellor<sup>®</sup> + 25</b>	9	0.0004	1,83	114	80 H	65	55	8,000	1220	0.00048	305x610x2030	12x24x80
<b>Ellor<sup>®</sup> + 40</b>	7	0.0003	1,78	111	75 H	60	60	8,700	1270	0.00050	305x610x915	12x24x36
<b>Ellor<sup>®</sup> + 50</b>	5	0.0002	1,86	116	95 H	80	76	11,000	1370	0.00054	305x610x915	12x12x36
<b>Ellor<sup>®</sup> + DS4</b>	4	<0.0002	1,88	117	95 H	72	90	13,000	1270	0.00050	305x610x102	4x12x24
<b>Ellor<sup>®</sup> + DS4C</b>	4	<0.0002	3,00	187	110 H	75	131	19,000	381	0.00015	305x203x51	2x8x12



## RECOMMENDED GRADES

-  SUITABLE
-  APPLICABLE

		GRADE	GRADE	GRADE	GRADE	GRADE	GRADE
		Ellor <sup>®</sup> +15	Ellor <sup>®</sup> +20	Ellor <sup>®</sup> +25	Ellor <sup>®</sup> +40	Ellor <sup>®</sup> +50	Ellor <sup>®</sup> +DS4
OPERATIONS	WIRE EDM						
	DEEP HOLES						
	FINES RIBS						
MATERIAL TO BE MACHINED	STEEL						
	REFRACTORY STEEL						
	TITANIUM, MOLYBDENUM, COOPER						
	TUNGSTEN, CARBIDE						



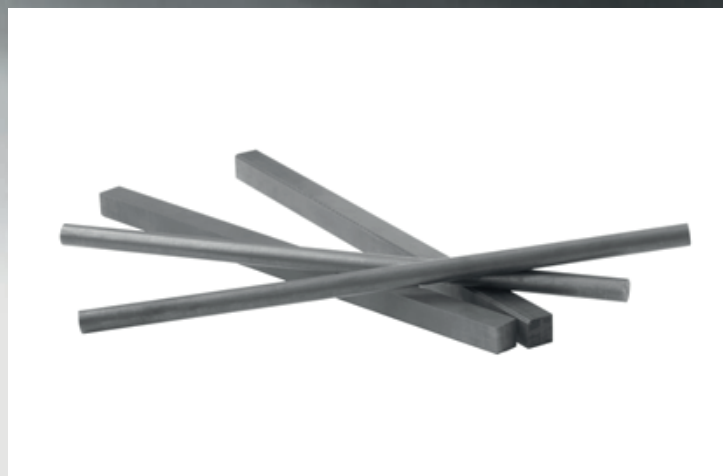
## SURFACE FINISH ACHIEVABLE ON STEEL WITH ELLOR<sup>®</sup> GRAPHITE

	FINISHING MODE				INTERMEDIATE						ROUGHING	
	Ellor <sup>®</sup> +DS4											
					Ellor <sup>®</sup> +50							
											Ellor <sup>®</sup> +40	
					Ellor <sup>®</sup> +25							
											Ellor <sup>®</sup> +20	
											Ellor <sup>®</sup> +15	
VDI 3400	12	15	18	21	24	27	30	33	36	39	42	45
Ra[μm]	0.40	0.56	0.80	1.12	1.60	2.24	3.15	4.50	6.30	9.00	12.50	18.00
Ra[μinch]	16	22	31	44	63	88	124	177	248	354	492	709

## READY TO CLAMP ELECTRODES



## SQUARE BAR, ROUND BARS AND FOIL SHEETS



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# OUR RECOMMENDATIONS TO GET THE MOST OF ELLOR® ELECTRODES

Good EDM results require not only the proper selection of EDM material, but also proper machine settings, such as peak current, on time, off time, gap size, electrode polarity and most importantly the flushing conditions.

## TIPS FOR ERODING WITH GRAPHITE ELECTRODES

### ROUGHING

- High discharge current causes high erosion and a rough surface

### SIZING

- Low discharge current causes a low removal and a fine surface

### SURFACE ROUGHNESS

- High discharge current causes high erosion and a rough surface
- Low discharge current causes a low removal and a fine surface
- Surfaces up to VDI 12 are possible, if given the right selection of graphite

### CONTOUR AND DIMENSIONAL ACCURACY

- Is always given due to the low thermal expansion of graphite
- Graphite is thermally stable and distortion-free

### TIME SAVING

- Through linking multiple electrodes

### AVOID ARCING

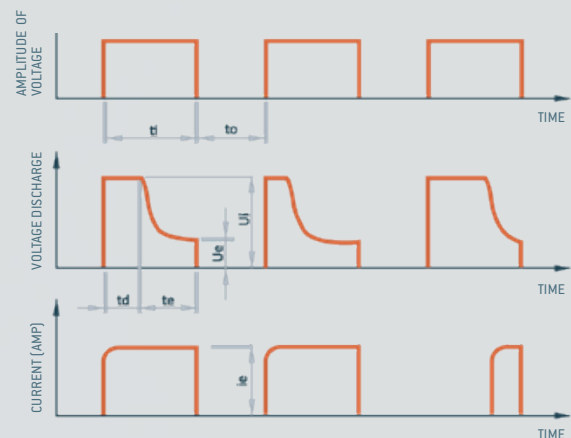
- Improve pulse duration
- Lower downtime
- Increase set point
- Improve flushing conditions

### ELECTRODE WEAR

- Decreases with increasing pulse duration and decreasing pulse break

## EDM DIE SINKING PROCESS

### CURRENT AND VOLTAGE SCHEMATIC VIEW



- [ti] pulse duration [S]
- [to] pause duration [S]
- [te] discharging duration [S]
- [Ui] open circuit voltage [V]
- [Ue] voltage discharge [V]
- [ie] current [Amp]
- [td] discharge delay time [S]

## 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
RECTIFICATION		100–2300	150–800	<3
SAWING		300–500	300–400	



GLOBAL EXPERT IN ELECTRICAL  
POWER AND ADVANCED MATERIALS

#### AMERICAS

MERSEN USA  
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

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MERSEN CHINA  
Chongqing, Kunshan  
& Yantai

MERSEN INDIA  
Bangalore & Pune

MERSEN JAPAN  
Tokyo

MERSEN SOUTH KOREA  
Seoul

MERSEN OCEANIA  
Fairfield Victoria

MERSEN TAIWAN  
Taipei