# SPECIALTY CARBONS FOR ELECTRICALLY CONDUCTIVE PLASTICS

**ENSACO**<sup>®</sup> Carbon Black





IMERYS CONDUCTIVE CARBON BLACKS – FIND THE PERFECT BALANCE OF ELECTRICAL CONDUCTIVITY AND OPTIMAL PROCESSING

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### APPLICATIONS FOR ELECTRICALLY CONDUCTIVE PLASTICS

There are an unlimited number of plastics where carbon blacks are an essential ingredient to give the plastics electrically conductive properties. These plastics are used in applications such as:

- Electronics and telecom: Handling of electronic components (carrier boxes, trays and tapes.) antistatic articles for computers and accessories and mobile phone parts.
- Medical: Clean-room equipment, articles for antistatic work environments.

- Industrial: Antistatic and conductive parts compliant with atex regulation, fans, containers, bins, pallets, wheels, PTC switches.
- Automotive: Fuel injection systems, anticorrosion systems, fuel tank inlets, electrostatically paintable parts, EMI shielding, sensors.
- Solution Building and infrastructure: Wire and cable, antistatic flooring, heating elements, antistatic and conductive pipes, geomembranes.
- Sector Packaging: Antistatic and conductive films.

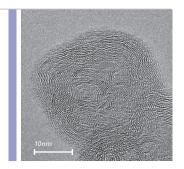




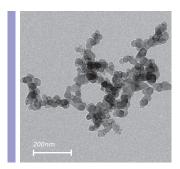
# ENSACO® CONDUCTIVE CARBON BLACK

**ENSACO**<sup>®</sup> electrically conductive carbon blacks are highly branched carbons (high structure) with a semi-graphitic micro-structure, that are able to transport a flow of electrons. At a certain concentration point, the percolation threshold, the carbon black forms a conductive network inside the insulative polymeric matrix. The higher the carbon black structure, the lower the level needed to achieve the required electrical conductivity.

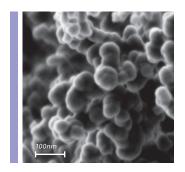
Low surface area conductive carbon blacks show a particular advantage for dispersion and processing. ENSACO<sup>®</sup> are a special family of conductive carbon blacks, produced through a proprietary method, that delivers extremely pure products (low metallics and sulphur content) with the unique combination of high structure and low surface area as well as low moisture pick-up.



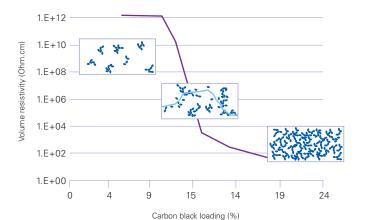
ENSACO® Primary particle – TEM picture



ENSACO® Aggregate
– TEM picture

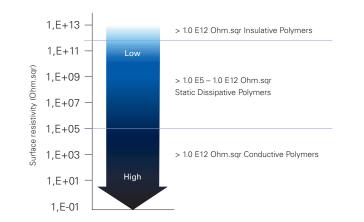


ENSACO® Agglomerate – SEM picture



Volume resistivity with ENSACO<sup>®</sup> grades

Higher carbon black loading increases electrical conductivity



Conductive carbon blacks are cost effective additives to achieve high permanent electrical conductivity.

# PROPERTIES

The ENSACO<sup>®</sup> family includes conductive carbon blacks as well as extra conductive carbon blacks which properties offer many advantages over conventional alternatives:

#### **ENSACO® TYPICAL VALUES**

PROPERTY TEST METHOD	UNIT	CONDUCTIVE		EXTRA CONDUCTIVE
		ENSACO® 250G	ENSACO <sup>®</sup> 260G	ENSACO® 350G
Form		Granules(*)	Granules	Granules
<b>BET nitrogen surface area</b> ASTM D3037	m²/g	65	70	770
OAN absorption ASTM D2414 (1)	ml/100g	190	190	320
Pour density ASTM D1513	kg/m³	170	170	135
Ash content ASTM D1506	%	0.01	0.01	0.03
Sulphur content ASTM D1619	%	0.02	0.02	0.02
Benzo[a]pyrene	ppb	<20	<20	<20

#### **ENSACO® TYPICAL EFFECTS ON POLYMER COMPOUND**

PROPERTY	CONDU	EXTRA CONDUCTIVE	
	ENSACO <sup>®</sup> 250G	ENSACO <sup>®</sup> 260G	ENSACO® 350G
Form	Granules(*)	Granules	Granules
Conductivity	+++	+++	++++
Dispersibility	+++	+++	++
Purity	+++	+++	++
Surface smoothness	+++	+++	++
Water absorption	very low	very low	high
Resistance to shear	+++	++++	+++

(\*) ENSACO® 250 is also available in powder form.

(\*) ENSACO® 250 is also available in powder form. (1): TLS = 400 mNm, 10 grams of carbon black

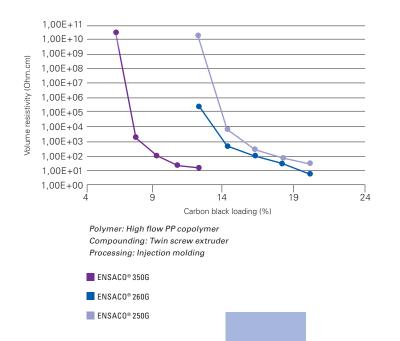
# HIGH ELECTRICAL CONDUCTIVITY AT LOW LOADING

### HIGH STRUCTURE CONDUCTIVE CARBON BLACK LEADS TO HIGHER ELECTRICAL CONDUCTIVITY

Percolation curves – correlating the volume resistivity and the carbon black percentage is a useful comparative tool during formulation development. These curves are valid for a given formulation (polymer type, other additives etc.) and processing technique.

Selecting the appropriate combination of polymer type and grade, as well as carbon black grade and loading level is determinant of the overall electrical and mechanical performance of a compound.

Volume resistivity with ENSACO<sup>®</sup> grades

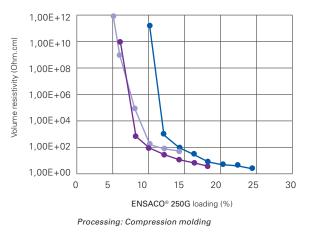


The choice of the polymer matrix will influence the volume resistivity. Compatibility between conductive carbon black and the polymeric matrix as well as polymer density impact the loading required to reach the required percolation threshold.

### HIGHER POLYMER FLUIDITY ENABLES HIGHER CONDUCTIVITY

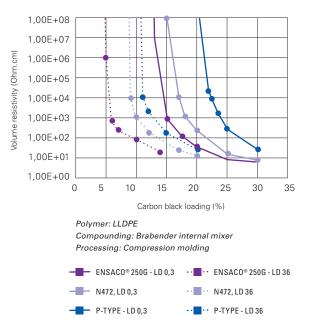
At equal structure, ENSACO® 250G the carbon black with a lower surface area, is more easily dispersed in the polymer matrix, improving resistivity. The higher the melt flow index (MFI) of the starting polymer, the lower the carbon black loading to reach electrical conductivity.

# Resitivity of compounds with ENSACO<sup>®</sup> 250G and different polymer matrix



HDPE

# Various carbon blacks in LDPE – MFI 0,3 or 36g/10min



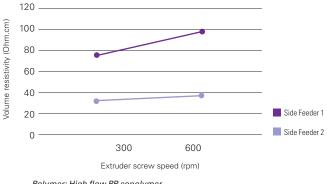
# ENSACO® CONDUCTIVE CARBON BLACK FOR OPTIMAL PROCESSING

Carbon black properties such as structure, purity, surface area, and moisture content will influence:

- Solution Compounding behaviour: Dispersibility, mixing cycle, melt flow index, extrusion throughput
- Surface appearance of the finished part: Presence of surface defects
- Mechanical properties:Polymer property retention, reinforcement
- ⊘ Overall price to performance ratio

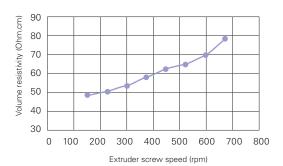
# PROCESSING INFLUENCE ON THE CONDUCTIVITY OF THE FINISHED PLASTIC PARTS

Excellent carbon black dispersion is key to reaching percolation at low loading. Conductive carbon black structure can evolve and be damaged by harsh processing conditions, such as high shear and compression work. Processing conditions play a key role on the final compound conductivity. It is recommended to add the carbon black, directly in the polymer melt, preferably in the second side feeder, to limit residence time as well as extruder screw rotation speed. Influence of carbon black feeding position (18% ENSACO<sup>®</sup> 250G in a high flow PP copolymer)



Polymer: High flow PP copolymer Compounding: Twin screw extruder Processing: Injection molding

#### Volume resistivity as a function of extruder screw speed (18% ENSACO® 250G in a high flow PP copolymer)



Polymer: High flow PP copolymer Compounding: Twin screw extruder Processing: Injection molding

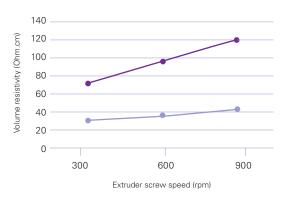


# ENSACO® CONDUCTIVE CARBON BLACK FOR OPTIMAL PROCESSING

#### PROCESSING INFLUENCE ON THE CONDUCTIVITY OF THE FINISHED PLASTIC PARTS

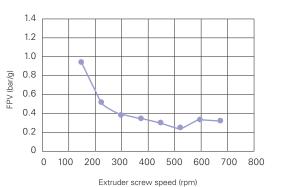
Influence of processing conditions is higher when the carbon black content is close to the percolation threshold. To reduce this effect, it is recommended to use a carbon black loading with a safety margin above the percolation threshold. The dispersion is improved by higher shear rate on the extruder. The lower the Filter Pressure Value (FPV), the better the dispersion. The processing technique selected also influences final part conductivity. Injection molding generates more shear and orientation than compression molding. This effect is enhanced close to percolation threshold. A safety margin for carbon black loading is recommended to overcome this phenomenon.

Volume resistivity evolution with extruder screw speed (PP high flow copolymer matrix)



Polymer: High flow PP copolymer Compounding: Twin screw extruder Processing: Injection molding

#### FPV as a function of extruder screw speed

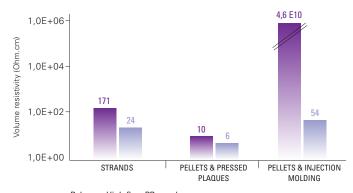


Test carried out with 18% ENSACO® 250G in polypropylene based

lest carried out with 18% ENSACO<sup>®</sup> 250G in polypropylene based compounds, the quality of dispersion was checked by FPV using the test described by ISO 9300-5 norm using a 14 μm screen.

Polymer: High flow PP copolymer Compounding: Twin screw extruder Processing: Injection molding

#### Volume resistivity measured on different samples made from PP based ENSACO<sup>®</sup> composites



Polymer: High flow PP copolymer Compounding: Twin screw extruder Processing: Injection molding

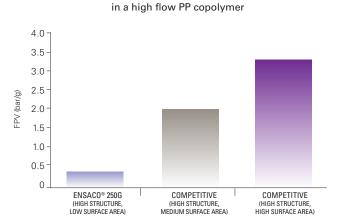
13.5% ENSACO® 250G 15% ENSACO® 250G

# ENSACO® 250G FOR EASY DISPERSION AND HIGH FLUIDITY

#### **ENSACO® 250G SOFT COMPACTION ENSURES EASY PROCESSING**

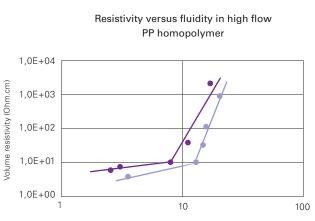
At the same structure level, ENSACO<sup>®</sup> 250G the carbon black with the lowest surface area has:

- An easy dispersibility as demonstrated by lower Filter Pressure Value (FPV)



Filter pressure value at 18% CB loading

Polymer: High flow PP copolymer Compounding: Twin screw extruder Processing: Injection molding



MFI @230°C/5kg (g/10 min)

Polymer: PP homopolymer Compounding: Twin screw extruder Processing: Tape extrusion

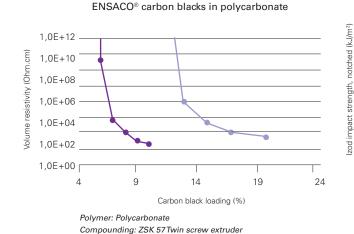
N472, High Surface Area ENSACO® 250G, Low Surface Area



# ENSACO® 250G LOW SURFACE AREA FOR IMPROVED MECHANICAL PERFORMANCE

### ENSACO® 250G AND ENSACO® 350G BASED COMPOSITES COMPARISON

ENSACO<sup>®</sup> 350G extra conductive carbon black has a very high structure and can therefore be used at typically half the loading of that of ENSACO<sup>®</sup> 250G conductive carbon black. At equal conductivity and at double the carbon black loading level, the mechanical performance of compounds produced with ENSACO® 250G is improved compared to that of compounds produced with the high surface area ENSACO® 350G.

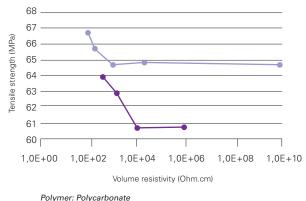


Volume resistivity of

12 11 10 09 strength, 08 07 06 05 04 r 4,0E+00 4,0E+02 4,0E+04 4,0E+06 4,0E+08 Volume resistivity (Ohm.cm)

Izod impact strength versus volume resistivity

Polymer: Polycarbonate Compounding: ZSK 57Twin screw extruder Processing: Injection molding Tensile strength versus volume resistivity



Compounding: ZSK 57 Twin screw extruder Processing: Injection molding

ENSACO® 350G ENSACO® 250G

Processing: Injection molding

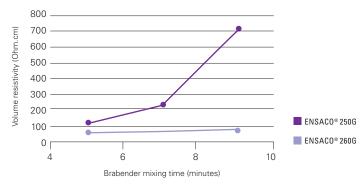
ENSACO® 250G ENSACO® 350G

ENSACO<sup>®</sup> 250G ENSACO<sup>®</sup> 350G



# ENSACO® 260G IS IDEAL FOR HIGH SHEAR APPLICATIONS

Volume resistivity versus mixing time (18% ENSACO® loading)



Polymer: HDPE Compounding: Brabender internal mixer Processing: Compression molding Due to its high graphiticity, **ENSACO® 260G** provides excellent shear resistance and improved compound conductivity, ideal for high shear applications.











With production sites in Europe, Canada and Japan and sales offices in Europe, America and throughout Asia we can ensure security of supply and an optimal customer experience.

#### **OUR EXPERTISE**

Imerys Graphite & Carbon is a global company focused on delivering carbon based solutions for manufacturing and industry.

We have over 100 years of experience in the development and production of a wide variety of high quality synthetic and natural graphite powders, conductive carbon blacks, silicon carbide and water based dispersions for various end applications including, but not limited to:

- ℅ Lithium-ion Batteries
- ⊘ Alkaline Batteries
- ✓ Lead Acid Batteries
- Solution Conductive Polymers, Plastics and Rubbers
- ⊘ Carbon Brushes
- Solution Brake Pads and Clutches
- Solution Powder Metallurgy and Hard Metals
- **⊘** Refractories

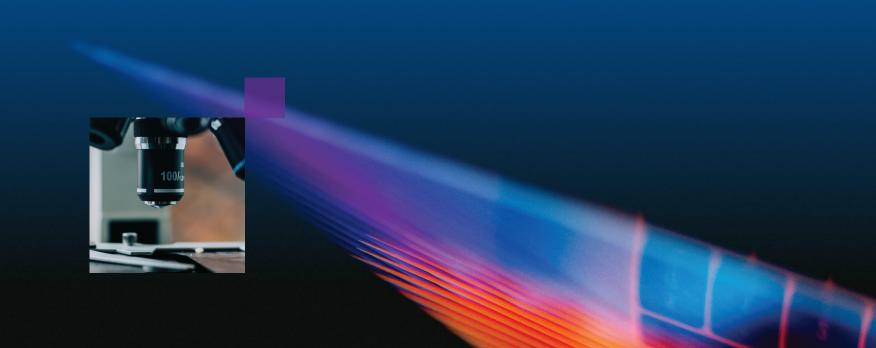
Our team of over 500 experienced professionals ensures we deliver optimal solutions for the technical challenges faced by our customers making us the market leader for:

- Conductive carbon blacks and graphites for lithium-ion batteries
- ♂ Graphites for alkaline batteries
- Graphites for resin bonded carbon brushes
- Solution Conductive carbon blacks for conductive polymers

#### **IMERYS GROUP**

Imerys Graphite & Carbon belongs to Imerys Group, the world leading supplier in mineral based specialties for industry.

The Group draws on its understanding of applications, technological knowledge and expertise in material science to deliver solutions based on beneficiation of its mineral resources, synthetic minerals and formulations. These contribute essential properties to customers' products and their performance, including heat resistance, hardness, conductivity, opacity, durability, purity, lightness, filtration, absorption and water repellency.

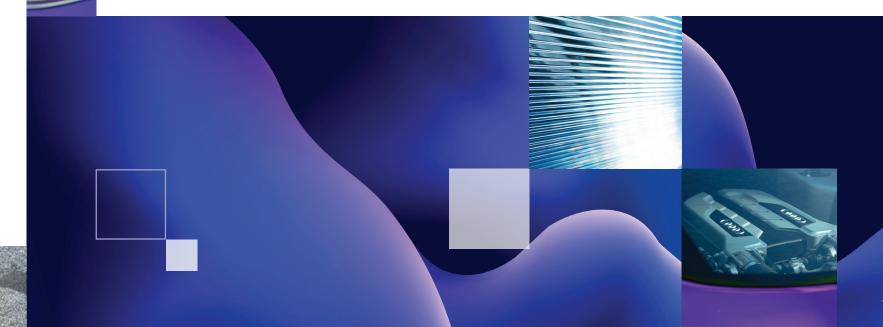












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