Mobile
Energy

SPECIALTY CARBONS FOR BIPOLAR PLATES OF FUEL CELLS

TIMREX®
TIMCAL Graphite

ENSACO®
TIMCAL Carbon Black

imerys-graphite-and-carbon.com

IMERYS
Graphite & Carbon

Imerys Graphite & Carbon

WHO ARE WE?

Imerys Graphite & Carbon has a strong tradition and history in carbon manufacturing. Its first manufacturing operation was founded in 1908.
Today, Imerys Graphite & Carbon facilities produce and market a large variety of synthetic and natural graphite powders, conductive carbon blacks and water-based dispersions of consistent high quality.
Adhering to a philosophy of Total Quality Management and continuous process improvement, all Imerys Graphite & Carbon manufacturing plants comply with ISO 9001:2008.
Imerys Graphite & Carbon is committed to produce highly specialized graphite and carbon materials for today's and tomorrow's customers needs.
Imerys Graphite & Carbon belongs to Imerys, the world leader in mineral-based specialties for industry.

WHERE ARE WE LOCATED?

With headquarters located in Switzerland, Imerys Graphite & Carbon has an international presence with production facilities and commercial offices located in key markets around the globe. The Group's industrial and commercial activities are managed by an experienced multinational team of more than 430 employees from many countries on three continents.

For the updated list of commercial offices and distributors please visit www.imerys-graphite-and-carbon.com

Lac-des-Îles, Canada
Mining, purification and sieving of natural graphite flakes

HQ Bodio, Switzerland
Graphitization and processing of synthetic graphite, manufacturing of water-based dispersions, processing of natural graphite and coke, and manufacturing and processing of silicon carbide

Changzhou, China
Manufacturing of descaling agents and processing of natural graphite

Terrebonne, Canada
Exfoliation of natural graphite, processing of natural and synthetic graphite

Willebroek, Belgium
Manufacturing and processing of conductive carbon black

Fuji, Japan
Manufacturing of water-based dispersions

WHAT IS OUR MISSION?

To promote our economic, social and cultural advancement with enthusiasm, efficiency and dynamism by offering value, reliability and quality to ensure the lasting success of our customers.

WHAT IS OUR VISION?

To be the worldwide leader and to be recognized as the reference for innovative capability in the field of carbon powder-based solutions.

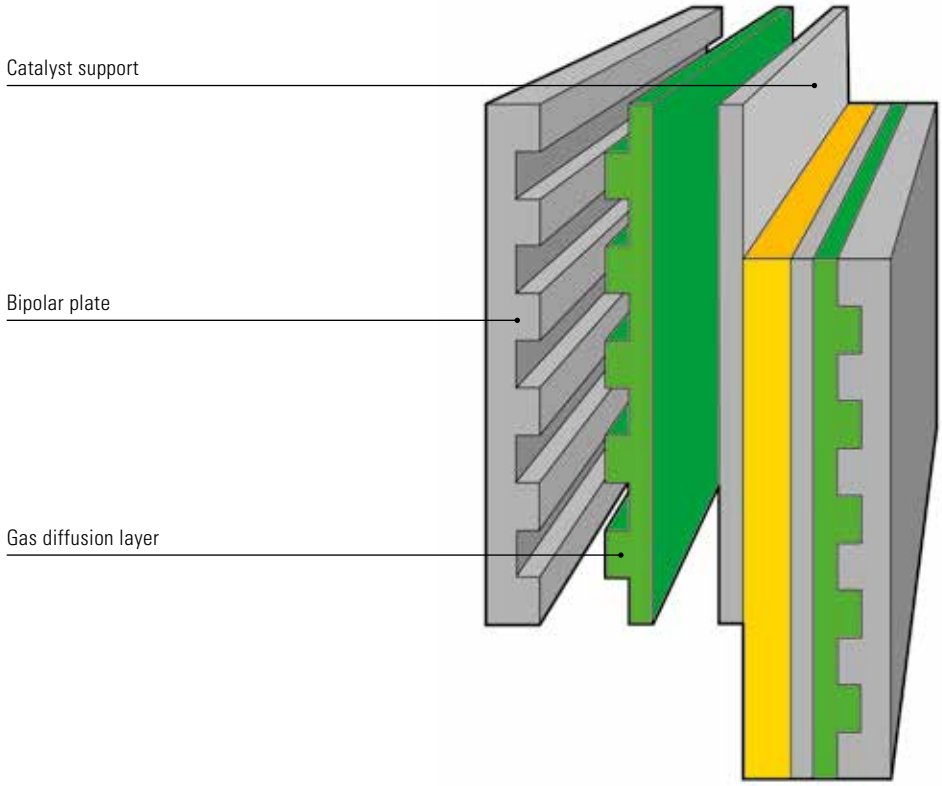
Carbons in fuel cells

CARBON POWDERS FOR BIPOLAR PLATES OF FUEL CELLS

Carbon materials are an essential element of most key components of fuel cells. This document is dedicated to carbon-polymer composite bipolar plates currently used in various fuel cell technologies. It is intended to help our customers to make the best possible selection from the wide range of Imerys Graphite & Carbon's materials available for the use in their bipolar plate. Imerys Graphite & Carbon offers technical expertise to its customers through its Marketing and R&D Groups. Our team of specialists possesses an extensive knowledge of carbon materials, polymers, compounding and corresponding application processes, as well as an excellent problem solving record.

CARBON MATERIALS IN OTHER COMPONENTS OF FUEL CELLS

Carbon material powders as well as dispersions, are used in gas diffusion layers, catalyst supports and as coatings for metall bipolar plates in fuel cell systems. Finally, graphite powder is also used as pore former in SOFC components.



BIPOLAR PLATES

The bipolar plate (BPP) is one of the key components in PEM and other fuel cell systems. It performs four basic functions in the fuel cell stack operation:

- Distribution of reactants, residual gases, and liquids.
- Current collection and electron transport from anode to cathode.
- Mechanical support of thin membrane electrode assemblies.
- Separation of the unit cells in the stack.

These functions correspond to key functional requirements for BPPs such as in-plane and through-plane (z direction perpendicular to the plane) electrical conductivity, and thermal conductivity to achieve stack cooling. Other functional requirements for BPPs include mechanical stability for stack integrity, hydrogen impermeability, resistance to corrosion for long life, low cost materials, and ease of manufacturing.

Graphite-based bipolar plates meet or exceed most of these key requirements.

BIPOLAR PLATES TARGET PROPERTIES	CARBON POWDER REQUIREMENTS
High electrical conductivity (through-plane)	High crystallinity and high pressed density, low anisotropy and rounder particle shape
High thermal conductivity (in-plane)	High crystallinity and high pressed density
Long life operation (low corrosion)	High purity carbons (> 99.8 %C)
Good mechanical properties	High pressed density
Easy processing of compound (low viscosity at high carbon loading)	Optimized particle size distribution, rounder particle shape

TIMREX® and ENSACO®
Specialty carbons for bipolar plates

Our carbon-related solutions for carbon-polymer composites have been optimized by selecting unique graphite grades as conductive and reinforcing fillers or by combining several carbon materials.
Our carbon-related solutions are compatible with both thermoplastics and thermosets and can be processed under a wide range of composition and conditions.
The corresponding carbon-polymer composite bipolar plates can be produced by either compression or injection molding.

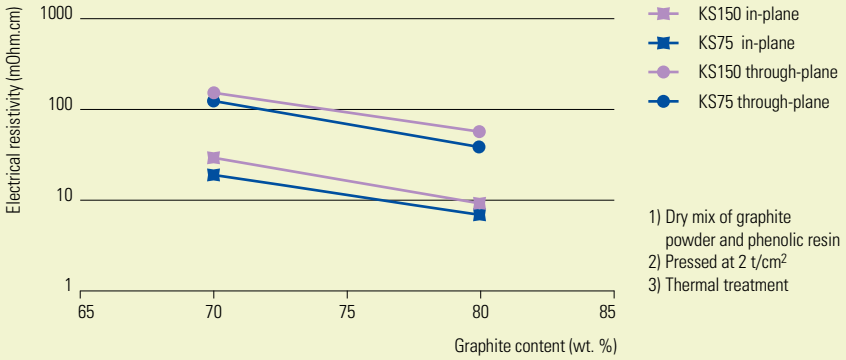
Our solutions are based on high-purity primary synthetic graphite, expanded graphite, and highly conductive carbon black.

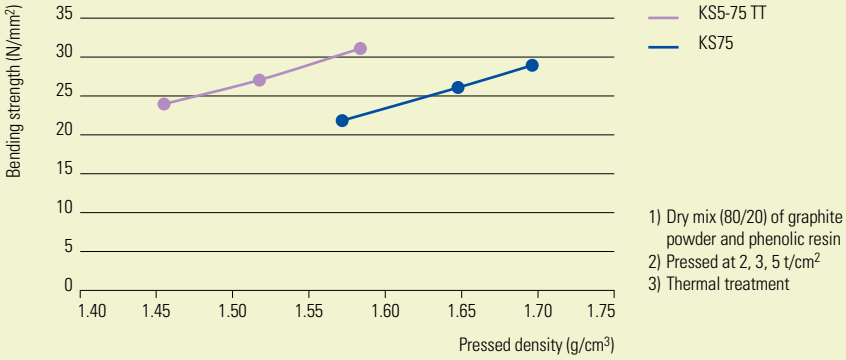
CARBON TYPE	ROLE	HIGH ELECTRICAL CONDUCTIVITY (THROUGH-PLANE)	HIGH THERMAL CONDUCTIVITY (IN-PLANE)	LONG LIFE OPERATION (LOW CORROSION)	GOOD MECHANICAL PROPERTIES	EASY PROCESSING (LOW VISCOSITY)
TIMREX® primary synthetic graphite	Main filler	+++	++	+++	++	+++
TIMREX® expanded graphite	Additive	+++	+++	+++	++	+
ENSACO® carbon black	Additive	+++	+	+++	++	+

GRAPHITE AS MAIN FILLER

TIMREX® highly crystalline primary synthetic graphite grades feature optimal particle shape, large crystallite size to ensure the mechanical stability, and high electrical conductivity. Primary synthetic graphite, with particle sizes (d90) ranging from 50 to 150 microns, performs very well in graphite polymer systems, while allowing the compound to be easily processed. Finer graphite is more difficult to handle (i.e. low density, dusting, and high compound viscosity) and typically results in lower conductivity, which is due to higher interparticulate contact resistance.
Coarser graphite powders display higher conductivity and allow better processing, yet reduce the mechanical stability of bipolar plates. Because the purity of primary synthetic graphite exceeds 99.9% in carbon content, this allows the carbon to exhibit superior performance and long life.
TIMREX® KS grades with medium to coarse particle size are commonly used in graphite-polymer composites. The highly isometric particle shape of KS grades results in good flowability, even at very high carbon loading that makes the compound easier to process. This allows the production of composite bipolar plate with high through-plane conductivity. Thus the low anisotropy of primary synthetic graphite is essential for optimum stack performance. The high crystallinity and the unique particle texture results in low oil (binder) absorption and more isotropic electrical conductivity.

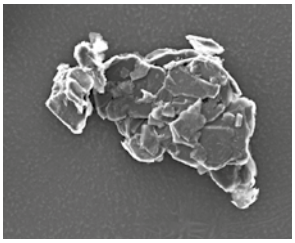
TIMREX® and ENSACO®
Specialty carbons for bipolar plates





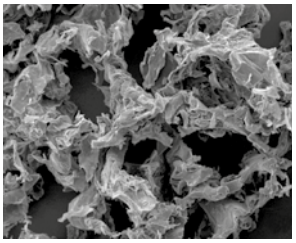
PRIMARY SYNTHETIC GRAPHITE AS MAIN FILLER					
TIMREX®	Carbon content	Surface area BET	Oil absorption	Particle size	Scott density
KS150	> 99.9 %	3.9 m²/g	47%	96% < 150 µm	0.34 g/cm³
KS75	> 99.9 %	7.2 m²/g	84%	d90 = 56 µm	0.24 g/cm³
KS5-75TT	> 99.9 %	4.4 m²/g	39%	d90 = 70 µm	0.44 g/cm³

Typical values



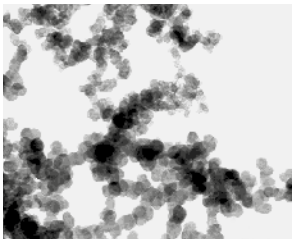
10 µm

SEM picture of primary synthetic graphite TIMREX® KS75



50 µm

SEM picture of expanded graphite TIMREX® BNB90

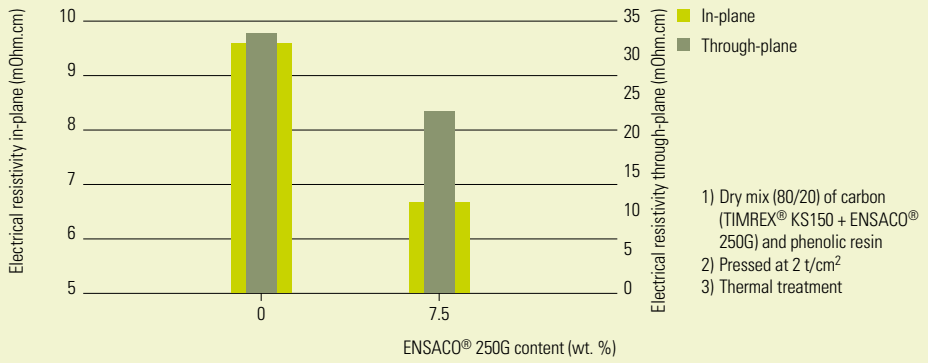


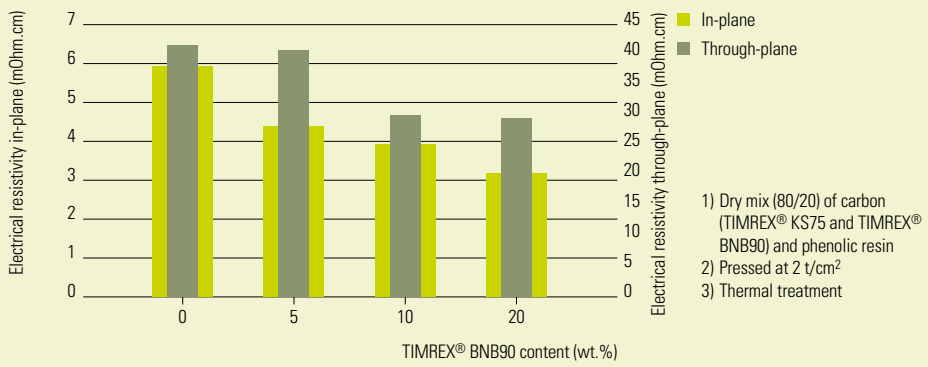
100000:1 200 nm

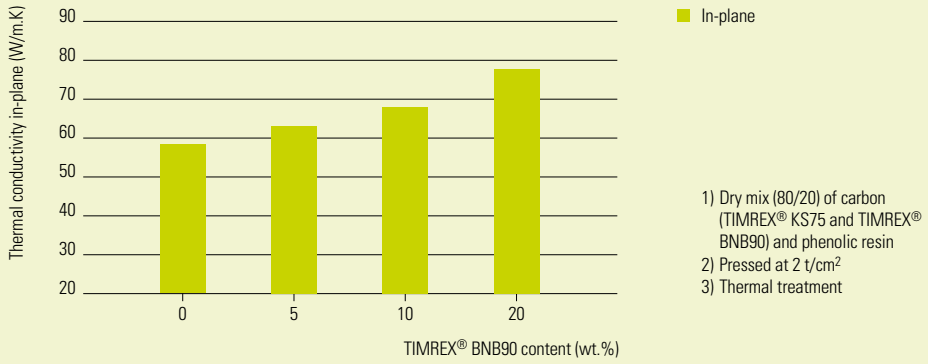
TEM picture of carbon black ENSACO® 250G

CARBON ADDITIVES AS MINOR FILLER

With TIMREX® KS grades as the main carbon filler, the performance of bipolar plates can be enhanced by the addition of expanded graphite and/or conductive carbon black. ENSACO® 250G is a conductive carbon black that can boost both in-plane and through-plane electrical conductivity of polymer-carbon composites.
TIMREX® BNB90 is an expanded graphite designed for applications requiring high electrical and thermal conductivity at low carbon contents. TIMREX® BNB90 can not only boost both in-plane and through-plane electrical conductivity, but also increase the thermal conductivity.
These materials are added in small quantities, since they may drastically increase compound viscosity.
The best solutions and the optimum concentration of minor fillers depend upon the target performance of bipolar plate, selection of polymer, compounding conditions, and molding process.







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