



Novel Solutions with Thermally-Conductive, Electrically-Insulating Compounds

Thermally conductive compounds are finding novel uses in emerging markets, presenting new opportunities as well as challenges for thermoplastic compounders. There is an increased focus on usage of plastic in component assemblies that need to dissipate heat while providing electrical insulation between system components.

Plastic is inherently electrically and thermally insulating. Plastic processors have traditionally extended plastics' reach by modifying its properties using various fillers and additives.

A new generation of CarboTherm™ Boron Nitride fillers by Saint-Gobain is now enabling novel applications in emerging markets for engineering plastic.

WHAT IS DRIVING THIS TREND?

The renewed focus on thermally conductive and electrically insulating plastic components is driven by a variety of factors.

- Megatrends such as fuel savings and electrical vehicles are driving weight reduction initiatives. Plastic parts allow 40 to 50% weight reductions compared to metal. In addition, each pound reduced in weight equates to additional fuel cost savings in component transportation in today's global supply-chain.
- Frequent design changes in system components in high volume end-user applications demand faster design and manufacturing cycles. This is easily achieved by widely adopted net-shape processes that enable custom solutions.
- Electronic and electrical devices are packing more energy in smaller sizes, making traditional metal heat sinks complicated and costly to die-cast in small intricate shapes. Plastic presents unique solutions with its ease of

processing. Furthermore, improved heat management while reducing component weight in the next generation devices enables lower power ratings, a feature very important for electrical equipment.

Besides the weight and ease-of-manufacturing advantage, thermoplastic also exhibit high strength-to-weight ratio, excellent resistance to corrosion, and recycling options.

TYPICAL APPLICATIONS FOR THERMALLY-CONDUCTIVE AND ELECTRICALLY-INSULATING PLASTICS

Thermally conductive and electrically insulating plastics open a broad range of new thermal management applications. Molded parts may replace metals, ceramics, and nonconductive plastics in a variety of applications.

Most notably, the combination of 'thermal conductivity' and electrical insulation' feature in a single component -combined with the ease of plastic molding - expands thermally conductive plastic's use beyond just replacing metals to replacing hybrid composite components.

Typical applications for thermoplastic polymers include custom-molded heat sinks on circuit boards, tubing for heat exchangers in appliances, insulation for high-speed rotating machine components, heat sink enclosures for LED bulbs, components for telecommunication devices, parts/enclosures for under-the-hood and electronic component-units in automotive.

ROLE OF THE FILLER: CARBOTHERM™ BORON NITRIDE

Thermoplastic compounds must have the required thermal conductivity to meet the needs of these applications. Common low-cost mineral or glass fillers cannot be used as the filler's thermal conductivity must be of a higher order of magnitude than the desired thermal conductivity of the final product. Metal, carbon and graphite fillers are also eliminated due to the electrical insulation requirement leaving only ceramic fillers as potential candidates.

Among ceramic fillers that are thermally conductive and electrically insulating such as hBN, AlN, Si₃N₄, SiC, Al₂O₃ and ZnO; hexagonal Boron Nitride (hBN) offers lowest density and low coefficient of friction. Low density facilitates maximum reduction in component weight, while lubricity supports reduced wear and improved equipment life cycle.

Fillers for Thermoplastic Polymers

Not found in nature, hexagonal boron nitride is manufactured from high-temperature synthesis of Boron and Nitrogen pre-cursors. hBN presents many benefits for polymer processing, along with high thermal conductivity and excellent electrical insulation:

- Lubricious and non-abrading – greatly reduces wear on injection-molding and extruding equipment
- White – particularly useful where white and clean appearance is critical, such as plastic components in food, medical and architectural systems
- Low density – enables low-weight plastic compounds compared to other thermally conductive fillers
- Low surface area – helps achieve higher loading levels, maximize thermal conductivity while maintaining mechanical integrity
- Available in large crystal sizes – allows maximum thermal conductivity
- Low coefficient of thermal expansion – helps replace metal or ceramic parts in dimensionally critical applications while enhancing electrical isolation of plastic compounders ease and flexibility to fit CarboTherm™ into their existing resin matrix
- Available in high-flow grades – Supports high-volume loading for automated polymer processing systems

CARBOTHERM GRADES FOR THERMOPLASTIC POLYMER PROCESSING

BN from Saint-Gobain is available in more than 50 grades, characterized by particle size distribution, tap density, surface area, purity and a whole host of other parameters.

The properties of a given hBN grade, while desirable in some applications, may lead to non-optimal flow characteristics and poor mixing in plastic processing. The requirements for plastic compounding are very unique. Optimum particle size, surface area, tap density, flow

properties, and mechanical properties of the filler – all play an important role in mixing, dispersion, as well as end-product characteristics.

Saint-Gobain's PCTF5, PCTP30D, PCTP40 and PCTH10MHF present a range of solution as plastic fillers:

PCTF5 – fine platelet grade for thin plastic applications

PCTP30D – free-flowing, loosely agglomerated powder designed for cost-sensitive, high-volume applications. Disperses uniformly by the high shear forces in the thermoplastic melt, exhibits optimum thermal conductivity, mechanical performance, and high throughput

PCTP40 – our largest size platelet powder, most suitable for applications requiring superior thermal conductivity

PCTH10MHF – premium grade, high-density agglomerated powder, recommended for improved in-plane (x-y plane) as well as through-plane (z-plane) thermal conductivity

CARBOTHERM THERMAL MANAGEMENT FILLERS FOR THERMOPLASTIC POLYMER COMPOUNDING – TYPICAL PROPERTIES

Grade	PCTF5	PCTP30D	PCTP40	PCTH10MHF
D50 (Mean) Microns	7	180	45	140
D100 (Max.) Microns	30	1500	250	200
Tap Density g/cc	0.3	0.6	0.5	0.8
Surface Area m ² /g	7	1	1.1	2.5

General Properties

Appearance	White	
Crystal Structure	Hexagonal	
Bulk Density	g/cc	2.2
Refractive Index	1.74	
Coefficient of Friction	< 0.3	
Dielectric Constant	3-4	
Thermal Conductivity	W/mK	30-130

Saint-Gobain has 50+ years of experience in synthesizing and refining Boron Nitride powders to specific process parameters.

For further information on CarboTherm boron nitride solutions, contact us at bnsales@saint-gobain.com.

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