3M Science. Applied to Life.™

3M Advanced Materials Division

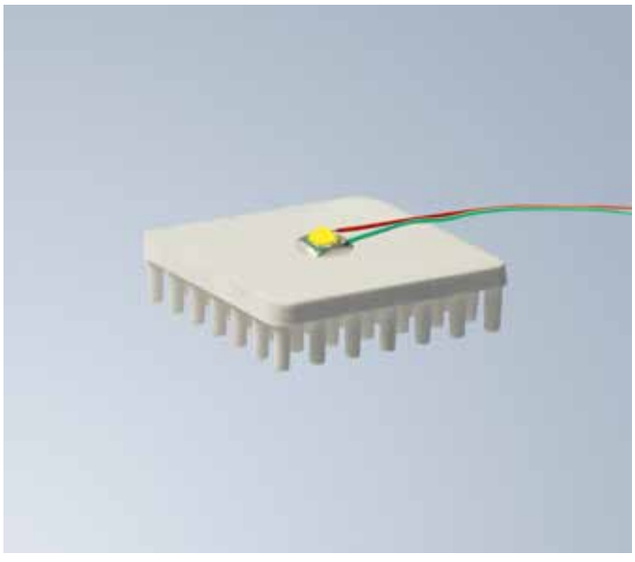
3M™ Boron Nitride Cooling Fillers

Smart Coolness for Excellent Performance

Highly thermally conductive and electrically insulating polymers are key production materials for electronic components

New growth markets require the substitution of metals or conventional polymer materials with highly thermally conductive polymer materials:

- LED lighting technology
- High-capacity battery technology
- Consumer and automotive electronics
- Thermal interface materials



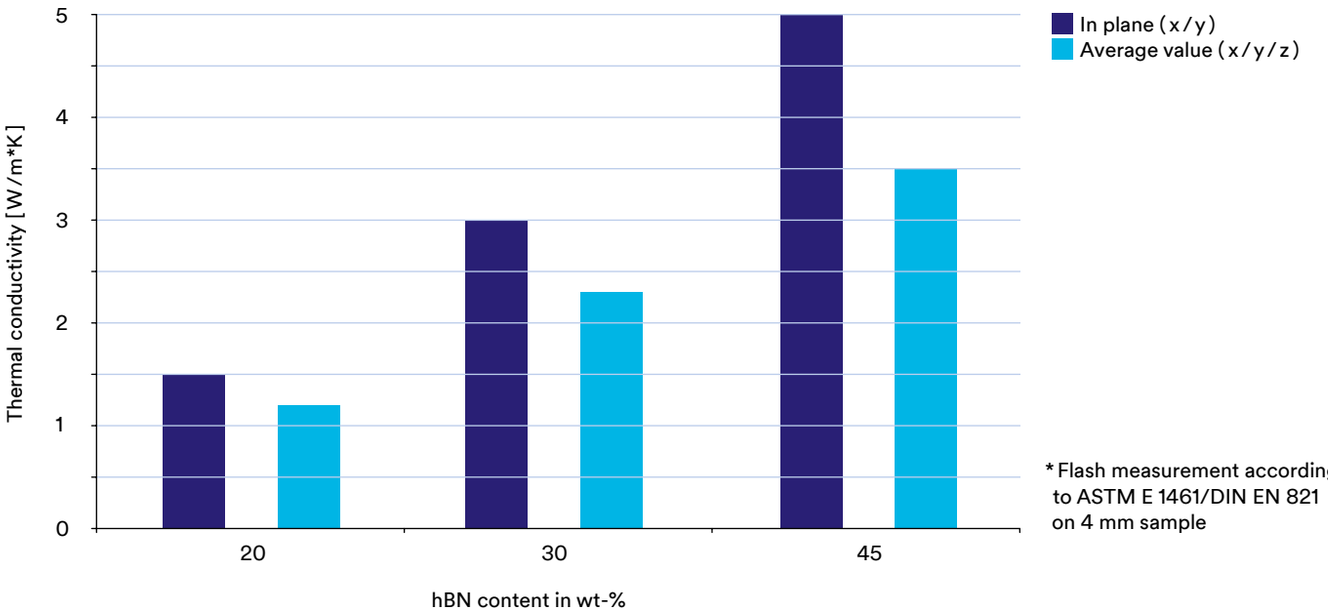
Application Services

In general 3M™ Boron Nitride Cooling Fillers can be incorporated in all polymer materials. Successful application experiences have been made with PA6, PA66, PBT, PPS, PEEK, LPS, TPE. For the application and filler-material development, 3M Technical Ceramics also performs compounding tests on a Leistritz ZSE 18 MAX dual-screw-type extruder upon request from customers. The thermal conductivity levels in compounds by 3M Technical Ceramics on a Netzsch Nanoflash LFA447. We can help you develop technically optimized solutions in a short amount of time – ask us about it!

Application example

Polyamide 66 with 20 – 45 wt-% 3M™ Boron Nitride Cooling Filler Platelets 15/400. In this example, no additional additives were used.

Thermal properties
PA 66 hBN compounds*



* Flash measurement according to ASTM E 1461/DIN EN 821 on 4 mm sample

3M™ Boron Nitride Cooling Fillers for thermally conductive and electrically insulating compounds

High thermal conductivity

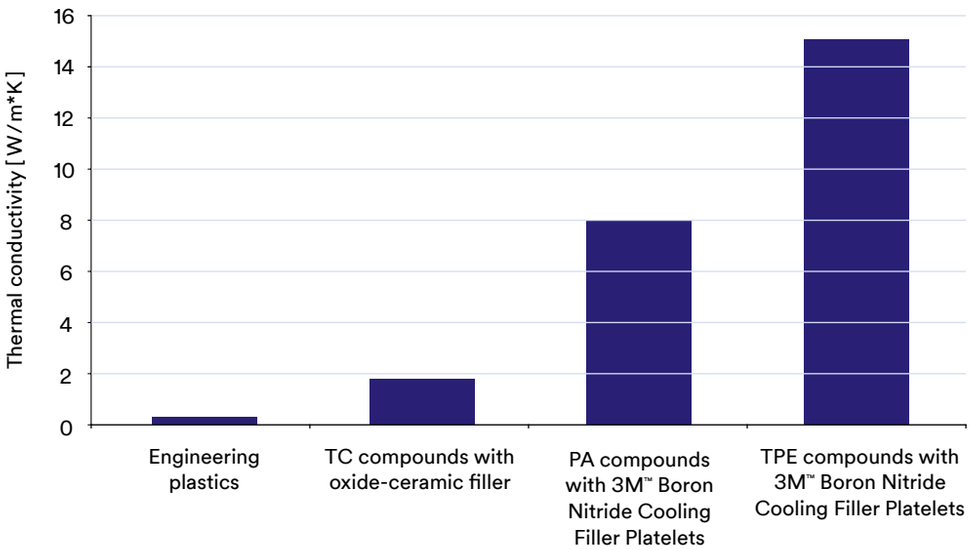
The maximum possible thermal conductivity in plastics is limited by the intended low-volume filling level and the low conductivity of the plastics' matrix. As a rule of thumb, the maximum achievable conductivity in the compound is lower than the conductivity of additives by a factor of 10. Thus, with Al_2O_3 filled compounds, only a maximum of 2 W/m*K can be achieved.

Compounds filled with 3M™ Boron Nitride Cooling Fillers can reach over 15 W/m*K with good processing properties. Hexagonal boron nitride (hBN) is the basis for Boron Nitride filling materials and has a thermal conductivity of up to 400 W/m*K (in-plane). The high thermal conductivity of 3M™ Boron Nitride Cooling Filler compounds is also supported by the high aspect ratio of the Boron Nitride particles (approx. 1:30). This allows for thermal conduction paths even at low concentrations. For example, thermal conductivity levels of > 5 W/m*K can be achieved even at filling levels of < 30 vol-%.

Electrical insulation

High insulation levels and breakdown voltages are among the basic requirements for compounds in electronic applications. When using electrically conductive additives such as graphite, the required levels can only be reached with additional insulation layers. However, these layers also constitute an additional heat flow barrier. Compounds filled with 3M™ Boron Nitride Cooling Fillers exceed the electrical insulation properties of basic polymers without the need for additional additives.

Comparison of thermally conductive plastics



3M™ Boron Nitride Cooling Fillers for systems with optimal price-performance ratio

Reduction of the overall costs for electrical modules

The functional integration of thermal conductivity and electrical insulation allows the simplification of processes and systems. Customized designs and the use of plastics processing options result in reduced low system costs.

Non abrasive processing

3M™ Boron Nitride Cooling Fillers' dry lubrication properties and low hardness (1 – 2 on the Mohs scale) ensure non-abrasive processing even at the highest filling levels. In contrast, conventional thermally conductive additives can have a hardness of up to 9 on the Mohs scale. Often, the effects of these additives only become apparent during serial production and exhibit as high abrasion to tools and systems as well as poor process stability. The resulting costs often outweigh the potential savings in raw material costs.

Low compounding costs

3M™ Boron Nitride Cooling Filler Platelets 15/400 were developed for screw type extrusion, which allows high production efficiency and process consistency. Due to the high bulk density and pourability, dusting is also prevented. For filling levels of over 30 vol-%, these properties are decisive for process costs and process stability. The power consumption during extrusion and thus the energy costs are drastically reduced in comparison to alternative, non-lubricating filling materials.

Combination with secondary filling materials

Due to the low required filling level when using 3M™ Boron Nitride Cooling Filler Platelets, compound developers have leeway to combine it with additional secondary filling materials. This can reduce raw material costs. For example, properties like mechanical strength can be achieved by adding glass fibers.

Short cool-down times

The extremely high thermal conductivity in Boron Nitride filled thermoplastics can result in shorter cool-down times for injection molding tools. Overall cycle time reductions of > 30 % have been achieved. The excellent heating and quick cool-down can also be applied economically in compounding.

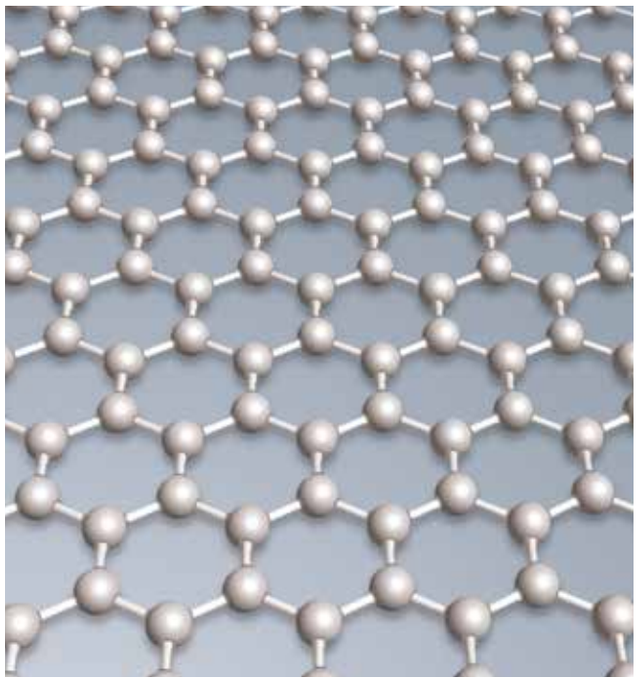
Environment and safety

The boron nitride powders contained in 3M™ Boron Nitride Cooling Filler (all grades) have been duly registered in conformance with REACH obligations according to EC directive 1907/2006 (Registration number see MSDS). The products do not contain any SVHC substance of the actual SVHC candidate list above a concentration of 0.1% (w/w).

Boron Nitride the white graphite as an insulator and heat conductor

Hexagonal boron nitride

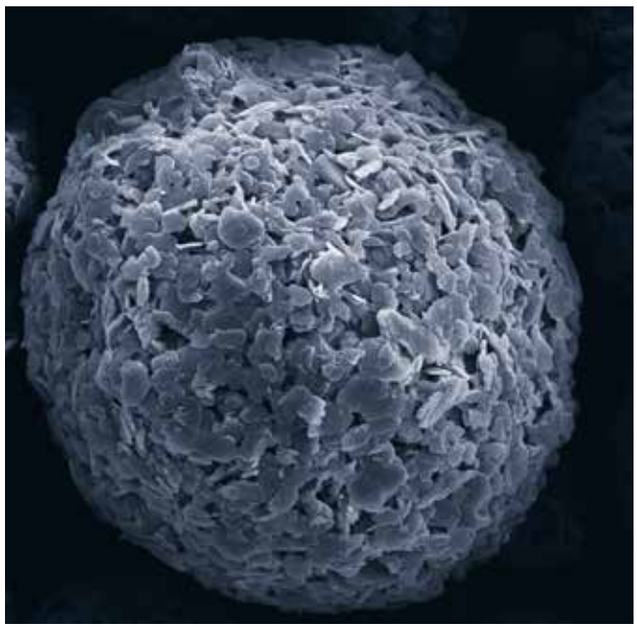
Hexagonal boron nitride (hBN) is manufactured synthetically from the raw materials melamine and boric acid. In an additional high-temperature glowing process, a hexagonal platelet structure develops – comparable to graphite. This also explains the advantageous properties like high heat conductivity and good lubrication due to layer gliding. In contrast to graphite, hBN has a pure white color and is not electrically conductive.



Hexagonal layer structure

3M™ Boron Nitride Cooling Filler Platelets 15/400 the solution for thermally conductive compounds

3M™ Boron Nitride Cooling Filler Platelets 15/400 is a simple and process reliable additive that allows thermal conductivity levels of up to 15 W/m*K to be achieved. Non-agglomerated hBN products cannot be processed economically with any process-reliability in compounding due to the low bulk density and lack of pourability. For filling levels >20 vol-%, the conveying characteristics of the filling material generally determine the economic feasibility of the process. The product Cooling Filler Platelets 15/400 is highly agglomerated and distinguishes itself through excellent pourability and high bulk density, and prevents processing problems linked to dusting. Even filling levels of over 50 % can be processed with economic throughputs and process-reliably in conventional extrusion systems. The agglomerates dissolve in the melted polymer mass even at low shear in individual platelets of approx. 15 µm which are necessary for achieving high thermal conductivity levels. Even at filling levels over 50 %, a good dispersion is achieved. Simple gravimetric side dosing is sufficient for common compound recipes.



3M™ Boron Nitride Cooling Filler Platelets 15/400 hexagonal layer structure 100 (REM recording)

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The management system has been certified according to DIN EN ISO 9001, DIN EN ISO 50001, DIN EN ISO 14001.

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