



Special Feature 2

Materials Business: The Electronics Segment Contributes to the Realization of a Prosperous World with Aluminum Nitride Ceramics

Great advancements in semiconductor device technology have been essential in the realization of a prosperous, modern world, from the development of telecommunications technology and the emergence of hybrid/electric vehicles to the development of equipment that uses lasers and reducing railway vehicle energy consumption. Furukawa Company Group member Furukawa Denshi Co., Ltd. manufactures and sells aluminum nitride (AlN) ceramics, which are heat-dissipating components essential for advanced electronic equipment.



// Advancing Electronic Equipment

Semiconductor devices fulfill their role of executing electric power control in various places and situations. They are a component of inverters for railway vehicles, and are used in large numbers to electrify and enhance the safe driving functions of vehicles, and their advancement is ongoing.

As semiconductor devices become more advanced, electric current capacity increases and circuits become complex and narrow. This results in a greater amount of heat generated, which has a problematic impact on other types of equipment.

// Trends in the Market for Electronic Equipment

According to World Semiconductor Trade Statistics (WSTS), developments such as the rapid increase in telecommuting due to the coronavirus pandemic and the reinforcement of data centers to accommodate the sudden increase in online traffic explain the dramatic increase in the volume of data transmission over the internet. Demand for electronic equipment is expected to increase even more in the field of telecommunications equipment with the advancement of 5G, local 5G, and other networks; the deployment of digital technology to maintain social distance and realize remote, contactless, non-face-to-face communication; increased rates of electronic components due to electrification in the automotive sector; and more. Advancing electronic equipment is essential for accommodating this increasing demand, and improving the heat-dissipation capacity of semiconductor devices is a challenge to overcome.

// Heat Dissipation Issues

Heat dissipation rarely came under scrutiny as a problem in the past because the semiconductor devices used in electronic equipment were not very heat-resistant to begin with. However, the New Energy and Industrial Technology Development Organization (NEDO) successfully developed circuit boards made of silicon carbide (SiC), which is more heat-resistant than conventional silicon (Si) circuit boards; highly heat-resistant SiC devices known as "power semiconductors" are widely used these days.

SiC devices can resist heat up to 450°C, which makes it possible



A furnace for manufacturing aluminum nitride ceramics

to manufacture slimmer, simplified electronic equipment. However, there are some problems, namely that other equipment near SiC devices is not as heat resistant, meaning that entire systems do not function properly if generated heat is not dissipated.

// Sharing Information about Issues

Commonly known heat dissipation problems include the danger of electronic equipment emitting smoke or sparks at high temperatures, the decline of device operating speeds, the increased frequency of poor operation and malfunctions, and shorter product lifespans; however, the causes of the problems differ for each electronic equipment manufacturer.

As Furukawa Denshi mainly sells to manufacturers of parts and materials for electronic equipment, the company cannot deal directly with the manufacturers of the actual electronic equipment when they are experiencing problems, making it difficult to identify the problems. The company has earned customers' trust by diligently answering their questions about the properties of the materials used and consulting to ensure that the components manufactured satisfy the required specifications, and is now experiencing a gradually increasing volume of inquiries regarding the central challenges.

Furukawa Denshi's AlN Products

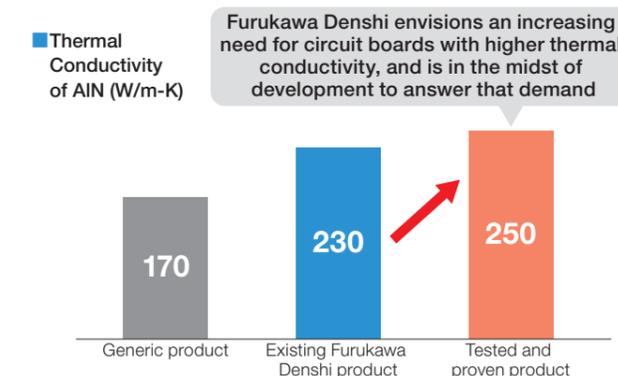
	■ Fillers	■ Parts	■ Substrates
Features	Powdery, high heat dissipation	Thermal uniformity, anti-corrosive, thermal conductivity	High heat dissipation/insulation
Main customers	Resin manufacturers, heat dissipation sheet manufacturers	Manufacturers of semiconductor manufacturing systems and high-voltage power units	Precision machining companies that manufacture semiconductor lasers and telecommunication elements
Main products in which the material is used	Silicone and other resin heat dissipation sheets and sealing material on smartphones, laptops, automobiles, etc.	Plates and other components of semiconductor manufacturing systems, high-voltage power units of railway vehicles and satellites/aircraft	Circuit boards for high-powered laser elements, high-powered LED (for camera flashes, projector lamps, etc.), telecommunication module parts

// Efforts Toward Issue Resolution

Furukawa Denshi has discovered issues in progress toward achieving practical applications of aluminum nitride. One is strength, and another is toughness. To resolve these issues, the company took advantage of an NEDO-subsidized project until last year and worked together with a national university and a national research and development agency to develop aluminum nitride ceramic circuit boards with superior mechanical properties (strength and toughness). Under the development project, the university handled and developed conditions for additives for improving properties, Furukawa Denshi used the materials to improve the strength and toughness of the circuit boards, and the research and development agency oversaw the underlying research and analysis, yielding a certain level of results. The company is using these results in efforts to develop technology for further enhancing properties and for aspects of manufacturing costs. The company also intends to answer demand for higher heat dissipation in systems and devices. Furukawa Denshi is exploring ways to resolve the most pressing issue with aluminum nitride ceramics—enhancing thermal conductivity. Toward that end, the company optimized the manufacturing conditions for AlN to successfully raise thermal conductivity from 230 W/m-K, which has long been the world's highest level for polycrystalline industrial ceramic materials, to 250 W/m-K, and plans to market the improved material during fiscal 2022.

For AlN, which has high insulation performance, to become more widely used as electronic equipment advances, it must

accommodate the varied conditions under which the equipment is used. Toward that end, it is necessary to continue to improve beyond the mechanical and thermal properties achieved with the latest efforts of Furukawa Denshi. We may also see the emergence of semiconductor device circuit boards with higher capacity than SiC. With the aim of maximizing the functionality of semiconductor devices, the company is tackling the challenges of improving the properties of AlN while lowering costs, and striving to develop other materials with greater capacity than AlN to help advance electronic equipment and deliver solutions to our customers.



Comments from Key Person

We receive many inquiries from customers experiencing issues with materials. I feel motivated when my interactions with customers and proposals to use aluminum nitride ceramics result in their gratitude for solutions to their problems.

AlN makes up only a small part of the Group's business. "Ceramics" may sound like a procedure for producing advanced chemical products, but it actually includes areas where baking things in furnaces is the only way to find out what will happen. We are proud of the trust we have earned from the market on the strength of the distinct technology we have painstakingly established through 30 years of trial and error, to the point where we now receive countless inquiries about AlN. We intend to continue providing thoughtful responses and suitable proposals that engender trust and solve customers' problems, thereby contributing to the realization of a prosperous world.



Teruo Kawashima, Chief Engineer, Sales Section, Sales Division, Furukawa Denshi Co., Ltd.