

Technologies

For Murata to continue to create new value, we must keep innovating technologies constantly. Murata has built an integrated system of production from raw materials to finished products and is developing technologies into platforms so that we can independently research, develop, accumulate, and apply a fundamental technology base to product development. In addition, we proactively collaborate with outside parties with the aim of creating new markets and innovations.

Introduction of the R&D framework

Murata has built an integrated system of production from raw materials to finished products. The Company's research and development activities also range from materials development to product design technology development, production technology development, software development, and analytical technology development. We strive to improve group-wide development efficiency by developing acquired elemental technologies as platforms and rolling them out across the Group. We also actively conduct joint research with external research institutions and are acquiring new technologies in anticipation of the future.

In the Components segment, we are driving the development of multilayer ceramic capacitors, noise suppression products, timing devices, sensor devices, RF components, batteries, etc., with the key words of miniaturization, slimming-down, and higher heat resistance. In the Modules segment, we are driving the development of communication modules, power supply modules, multilayer resin substrates, etc., with the key words of miniaturization, higher

functionalities, multi-functionalization, and lower power consumption. In the Communication Modules segment, we are promoting the development of technologies to meet needs in safety and energy management, particularly in the automotive market. In the Research and Development Department, we are developing new technologies and products especially for the automotive, energy, healthcare/medical, and IoT markets, with the goal of cultivating new markets and driving innovation.

Murata's research and development framework consists of the Corporate Technology & Business Development Unit, Production Engineering Unit, Components Business Unit, Module Business Unit, and Medical Products Department. The business units and business promotion departments are mainly engaged in technological development for product types that they oversee, and the development of new products. The Corporate Technology & Business Development Unit and Production Engineering Unit mainly focus on technological development for new business creation, as well as the development and platform creation of elemental technology.

Close Up!

Murata develops millimeter wave (60GHz) RF antenna module contributing to the creation of next-generation high-speed wireless networks

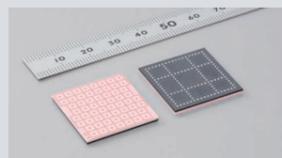
In recent years, the need is growing for faster Internet communication in line with the increase in bandwidth required by Internet contents such as ultra-high definition (HD, 4K) video, augmented reality (AR), and virtual reality (VR). On the other hand, constructing wired networks that cover wide areas requires enormous amounts of cables and labor, and the costs of constructing and maintaining this infrastructure are also considerable.

To respond to these needs, Murata has commercialized and begun mass-production of an RF antenna module that realizes broadband communications required for creating the next-generation high-speed wireless networks.

Thanks to the use of an independently developed LTCC* substrate which realizes stable communications quality as well as high heat resistance and high moisture resistance, it performs well in outdoor applications such

as in the base stations of telecommunications carriers. Furthermore, the new module is anticipated to be utilized in a wide range of applications such as for communication between mobile phone base stations including next-generation 5G wireless communication, for communication between wireless LAN hotspots, and for use in wireless communication networks in smart cities.

Murata will contribute to the creation of next-generation networks by developing various communication modules with an eye to the response to even faster wireless LANs and the next-generation 5G wireless communication standard.



* Abbreviation of Low Temperature Co-fired Ceramics: Refers to ceramics fired at temperatures of 1,000°C or lower

Platform technologies and core technologies

Murata has five platform technology domains, and each platform technology is comprised of several core technologies. Each core technology has been

refined over a long period within Murata, and has become a source to differentiate from competitors and create technological innovations.

Platforms

Materials technology	Materials design	Materials processing				
Front-end process technology	Laminating & stacking	Printing	Sintering	Nano & thin film fabrication	Surface finishing	Precision mechanical processing
Product design technology	High frequency design	Device design	Embedded	High reliability design	Circuit design	Simulation
Back-end process technology	Packaging	Measurement	Automation	Industrial engineering		
Analytical technology	Materials characterization	Failure analysis				

Materials technology

Materials technology is the technology to simulate and model material composition, crystal structures, and electrical properties, as well as to disperse and combine these materials while controlling ceramic particle sizes and crystal structures.

al materials, structural engineering, and software; technology to design systems by utilizing both circuit design and embedded software design; technology to achieve high reliability under harsh environmental conditions; technology to optimize parts compositions in order to achieve high efficiency and small circuits; and simulation technology to analyze electromagnetic fields, heat, and stress.

Front-end process technology

Front-end process technology includes the technology to laminate and align small and uniform crystal particles by forming them into dielectric sheets in a submicron size or less with high precision; technology to thinly and accurately form internal electrodes and wirings on ceramic sheets using methods such as screen printing; technology to create ceramics with desired crystal structures by precisely controlling temperature and atmosphere; technology to form thin films on a submicron level using lithography and etching; technology to improve surface properties of electronic components while controlling electrochemical parameters using plating technology; and technology to form highly precise and complex structures using injection forming and press forming.

Back-end process technology

Back-end process technology includes the technology to achieve miniaturization and high reliability of devices through high-heat resistance connections and air-tight sealing; technology to quickly and accurately measure electronic properties and other characteristics of products; technology to design equipment that transports extremely small products in different shapes at high speed and with low damage; and technology to improve productivity by analyzing manufacturing methods and scientifically managing them.

Product design technology

Product design technology includes the technology to design RF components and modules while considering complex electromagnetic couplings and circuit constants within the circuit; technology to achieve high performance and small devices using function-

Analytical technology

Analytical technology includes the technology to physically and electronically evaluate material compositions through non-destructive analysis, heat analysis, organic and inorganic analysis, and surface analysis; and technology to identify the cause of failures occurred in materials and products through the abovementioned analytical methods.