

### Research and Development

The MinebeaMitsumi Group manufactures and sells precision machinery components like ball bearings and components incorporating ball bearings, aircraft parts, like rod-end bearings and high-end fasteners, as well as motors and pivot products employed in state-of-the-art hard disk drives (HDDs). MinebeaMitsumi's lines of products also include various types of electronic components such as motors used in electronic devices, LED backlights, lighting equipment, strain gauges and the load cells and sensors that use them, as well as EMS (Electro Mechanics Solutions) and products that integrate all of these basic technologies. MinebeaMitsumi has research and development facilities at its Tokyo Head Office, its Karuizawa, Hamamatsu, Fujisawa, Matsuida, and Yonago Plants as well as in the United States, Europe, Thailand, and China. These bases leverage their individual areas of expertise while working with each other to speed up the development of new products and create new business opportunities.

The Tokyo Research & Development Center, which was set up at our Tokyo Head Office in 2013, takes full advantage of its prime location in Tokyo, a dynamic hub for human resources and information. Work is currently underway at the Center to develop EMS products for medical and in-vehicle applications. Our facilities in Karuizawa and Hamamatsu, as well as the Material Science Laboratories in Thailand and China have implemented an ISO 17025-compliant management system and are moving the entire MinebeaMitsumi Group forward in analyzing emissions of hazardous substances targeted by environmental regulations, including those banned by the European Union's Restriction of Hazardous Substances (RoHS) directive as well as conducting product certification tests for electronic components.

On January 27, 2017, we realized our business integration with MITSUMI ELECTRIC CO., LTD. and embarked on a new start to our research and development activities by focusing on synergy and mutually leveraging our strengths in creating products. In other words, by combining MITSUMI ELECTRIC CO., LTD.'s input, conversion and control devices and MinebeaMitsumi's output devices, we aim to pursue the development of Electro Mechanics Solutions (EMS) and high value-added solutions and to create enhance devices that look to future developments in IoT, and aiming to enter the smart, in-vehicle, and industrial/robotics fields with these products and solutions.

During the year under review, our group-wide R&D expenses totaled ¥12,347 million. This amount includes ¥813 million in basic research expenses that cannot be allocated to any particular segment, such as analysis conducted at our Materials Science Laboratories in Thailand and China.

Here is an overview of the R&D activities conducted by each segment during the year under review.

#### Machined Components

R&D in this segment remained geared toward our mainstay bearing products (i.e. ball bearings, rod-end bearings, etc.) with a focus on developing basic tribological technologies for materials and lubricants, as well as ultra-low wear self-lubricating liners (Mineron™), etc. (Mineron™ is a MINEBEA MITSUMI Inc. registered trademark in Japan).

We are working with a keen eye aimed at responding to the needs of manufacturers in emerging areas of the IT, home electrical appliances, automobile, aerospace, and medical equipment industries. Reliability engineering focused on minimizing particle generation, increasing heat resistance, extending product life, enhancing electroconductivity, etc. as well as applied engineering are at the heart of our work in this area.

The miniature ball bearings that are so essential to precision machining technology can be found hard at work in HDD pivot assemblies. As a leading manufacturer in this area, we are developing new products for a wide range of applications in the HDD market's growing data center server, nearline, and mobile device segments, as well as highly reliable grease for pivot assemblies.

Recent progress in the area of aircraft bearings includes the development and approval of mechanical assemblies, trunnion bearings for main landing gear, and a wide range of bearings that will go into flight control systems for U.S. and European aircraft manufacturers. These R&D successes incorporate the same technology found in our rod-end bearings.

Our overseas consolidated subsidiary, myonic GmbH, developed high-heat-resistant ball bearing units for automobile engine turbochargers. Used to boost the output of engines that are made smaller to meet environmental regulations, turbochargers have been garnering a lot of attention in recent years. Applications have expanded to include not only general vehicles but also eco-friendly cars.

In 2013, we acquired all shares in CEROBEAR GmbH, a German company boasting more than 20 years of experience in the design, manufacturing and marketing of ceramic bearings and hybrid bearings employing high performance steel materials. CEROBEAR's technological capability combined with myonic GmbH's technological edge in providing special bearings used in dental and medical equipment as well as the aerospace industry enables us to develop new products for the aerospace industry that are expected to be in great demand while maximizing synergy between the two companies.

In addition, we launched the Wavy Nozzle, which is a new product now sold in the machine tool market is a coolant sprayer born from improvements we made to our own manufacturing operations.

R&D expenses in this segment totaled ¥1,738 million.

#### **Electronic Devices and Components**

Motors, one of the principal product lines of the electronic devices and components business, includes HDD spindle motors, stepping motors, DC motors, air movers (fan motors) as well as precision motors. We are currently working to enhance basic technological capabilities, including various simulation, analysis, control, and material technologies as well as product development capability, so that we can be the first in the market to supply advanced products meeting customer needs for smaller, more efficient (energy-saving), quiet, and reliable products required for a wide range of applications.

We are also harnessing our expertise in materials and manufacturing technology to develop magnetic products. Ongoing work in this area continues to yield such outstanding products as rare earth bond magnets and heat-resistant magnets for use in high-performance motors.

Our HDD spindle motors, featuring MinebeaMitsumi's proprietary fluid bearing design, have been carefully engineered for data center applications where high reliability is a must.

Work in the area of optical products, includes the development of our ultra-thin LED backlight units for mobile devices that are making larger and thinner smartphones possible.

In addition to MinebeaMitsumi's signature ultra-precision machining and precision mold technologies, we are also improving the technology for injection molding of transparent resin that allows fine optical patterns to be quickly and precisely transferred to LED backlight guide plates. Using this technology, we have developed ultra-thin guide plates for 5-inch class smartphones. Measuring less than 0.3 mm in thickness, these guide plates are the thinnest in the industry. On the manufacturing end, we have introduced an automated assembly machine and appearance tester for LED backlights for LCDs, by all employing our own technologies that have given us a leg up in mass production. We are also putting the optical technologies that we developed for LED backlights for LCDs to work in developing LED lighting products that combine LED lighting circuits with thin LED lighting lenses. Thinner and more efficient than conventional products, these LED lighting products are extremely energy efficient. We are working to develop technologies to make them even more efficient.

We are developing wirelessly controlled LED lighting devices for smart buildings and smart cities that incorporate the wireless technology of PARADOX ENGINEERING SA, our consolidated subsidiary. Rolling out the results of this development, we are using the Joint Crediting Mechanism for the reduction of greenhouse gases, to promote the installation of highly efficient, wirelessly controlled LED street lighting in Cambodia.

In the LED lighting business, we have developed and started marketing of SALIOT, which can manage and control a light distribution angle and brightness both horizontally and vertically with ease by smartphone or tablet, utilizing our motor and wireless technology.

In the sensing device business, we launched a joint research project by using measuring components applying strain gages in collaboration with Chiba University Graduate School of Medicine and Chiba University Hospital with its sights set on the development of a biological information monitoring system, and we plan to develop and commercialize such products for the healthcare and nursing care markets.

In July 2014, we acquired a stake in Japan 3D Devices Co., Ltd., a subsidiary of Okamoto Glass Co., Ltd. and a maker of concave mirrors (reflectors) for automotive head-up displays and other high precision 3D molded thin glasses. The acquisition has enabled us to step up our efforts to develop basic and applied head-up display technologies.

R&D expenses in this segment totaled ¥7,230 million.

#### **MITSUMI Business**

R&D in MITSUMI business consists of development of high-accuracy image stabilization mechanisms for camera actuator for smartphones, ultra-thin actuators, modules and semiconductors related to lithium-ion rechargeable battery, various sensors, haptic technology, as well as researching into elements of Micro Electro Mechanical Systems (MEMS) and developing peripheral components, etc.

R&D expenses in this segment totaled ¥1,735 million.

#### **Other**

Our other segment mainly includes machines made in-house.

R&D expenses in this segment totaled ¥831 million.