RESEARCH AND DEVELOPMENT

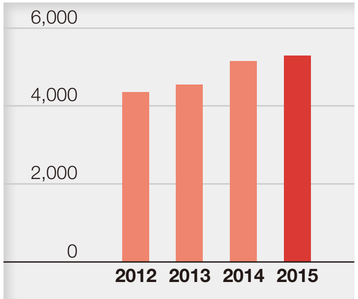
The Daido Steel Group's basic management policy is to leverage its advanced technology capabilities in specialty steel to "foster a corporate culture of creativity and originality that contributes to the 21st century society." Based on this policy, the Group conducts a proactive program of research and development (R&D) to expand new products and businesses and strengthen the foundations for existing businesses.

We are pursuing R&D for new products, materials and technologies, primarily through the Daido Corporate Research & Development Center, which houses the Special Steel Research Lab, Electromagnetic Material Research Lab, and Process Technology Development Center. We employ a total of 275 researchers throughout the Daido Steel Group (as of March 31, 2015).

R&D expenses for the Daido Steel Group during the fiscal year under review amounted to ¥5,301 million. An explanation of our R&D efforts by segment, including purpose, major achievements, and expenditures follows.

R&D EXPENDITURES
Years ended March 31

(millions of yen)



(1) Specialty Steel

In this segment, R&D includes basic material development, such as automotive structural materials and tool steel, and process innovations ranging from steelmaking, refining and solidification to quality assurance.

R&D costs for the fiscal year under review in this segment totaled ¥1,469 million.

- **Development of steel for gears with excellent manufacturability**

In order to balance fatigue strength, wear resistance at the surface and toughness in the core portion of gears, high-temperature carburizing treatment is generally utilized. However, occasionally localized coarsening of the crystal grain (non-uniformity of grain size) occurs during carburizing, causing property deterioration such as strength reduction. Therefore, we developed a technology that controls grain size uniformity and reduces property deterioration. We are studying its practical application in various types of steels. The new steels associated with this technology also reduce the carburizing costs by requiring shorter treatment times at high temperatures.

- **PVD coating (HT-CERAC) for high-strength steel sheet processing**

In creating lighter parts to improve automobile fuel efficiency, it is necessary to enhance the strength of steel sheets. Therefore, the surface of the processing tool in the press process of steel sheets is coated with hard film. However, the film soon peels off due to the high pressure processing required for high-strength steel. This peeling of the film leads to frequent tool changes. With enhancement of steel sheet strength, a more durable film has been sought.

To meet this need, we have developed the PVD coating "HT-CERAC." Because HT-CERAC lasts at least five times longer than conventional coatings, it improves production efficiency by reducing the tool change frequency, and is expected to be widely adopted in the future.

(2) High Performance Materials and Magnetic Materials

In this segment the Daido Steel Group conducts R&D focusing on developing materials that resist corrosion and heat, high-grade strip steel, welding materials, magnetic materials and electronic devices. Magnet research is carried out principally by the Company and its consolidated subsidiary, Daido Electronics Co., Ltd.

R&D costs for the fiscal year under review in this segment totaled ¥2,568 million. The following are some of our major achievements in this area.

- **Hot-deformed magnet containing no heavy rare-earth elements**

We have developed ND-40SHF, a neodymium-iron-boron (Nd-Fe-B) hot-deformed magnet with record-high magnetism and thermal resistance without any heavy rare-earth elements, specifically dysprosium (Dy) and terbium (Te) which are both rare and expensive. Demand for high-performance magnets is expanding, especially in the automobiles, consumer electronics, and energy fields. These fields require high thermal resistance. Conventional neodymium magnets show their thermal resistance due to the addition of heavy rare-earth elements, but as nearly all heavy rare-earth elements are produced in China, their high price and unstable supply are a major concern. As a magnet with no heavy rare-earth elements, ND-40SHF has achieved the world's highest level of magnetism and thermal resistance in rare-earth-free magnets through the newly developed hot plastic-deforming method and optimization of magnetic composition.

Daido Electronics supplies the magnets for motors in automobiles, in particular for the growing electronic power steering (EPS) market, as well as industrial machinery, office automation equipment and consumer electronics markets.

- **Development of high-elasticity titanium alloy TNCZ**

We have developed TNCZ, an innovative titanium alloy with improved flexibility and cold workability (formability) compared with conventional materials, and began its mass-production as wire rod in October 2014. TNCZ is a beta-type titanium alloy without nickel and vanadium, developed for medical use. It is composed of non-toxic elements (titanium, nickel, chrome, and zirconium). In addition, TNCZ enables the formation of complex shapes in which conventional titanium alloys cannot be used as a result of its good flexibility and formability. TNCZ is expected to be used in medical equipment, such as catheter guide wires, guide pins, and stents. We are working with customers to develop its applications for such products as eyeglass frames, automobile parts, and watch cases.

(3) Parts for Automobile and Industrial Equipment

R&D in this segment concentrates on development of turbochargers and other automotive parts and parts for various types of industrial machinery.

R&D costs for the fiscal year under review in this segment totaled ¥1,127 million. The following are some of our major achievements in this area.

- **High-heat-resistant titanium aluminide turbocharger wheel**

Because of improved automobile fuel consumption, demand for more compact engines along with turbochargers that convert, use and raise exhaust gas energy output is increasing. The turbine wheel, a key structural component of the turbocharger, is generally made from a nickel-based super-alloy that is highly heat resistant. To increase responsiveness at the time of startup, we have developed titanium alloys with approximately half the specific gravity of nickel-based super-alloys and the same or greater heat resistance, and have been producing them at a mass-production level. Now, we have developed a new titanium alloy, DAT-TA3, with improved high-temperature strength, high-temperature creep property, and a higher heat resistance temperature. In the future, with the tightening of environmental regulations and demands for a higher-performance turbocharger, the DAT-TA series are expected to be used in an even wider range of applications.

- **Development of high-strength automobile exhaust valve steel**

Heat-resistant austenitic steels have been generally used as materials for exhaust values in automobiles, but in high-performance engines operating at even harsher environmental temperatures, high-temperature-strength nickel-based super alloys or iron-nickel-based super alloys have been used hitherto. Now, we have developed the highest-grade iron-based heat-resistant austenitic steel, which surpasses conventional heat-resistant steels and has a good balance between higher strength through solid solution and carbide precipitation and long-term structural stability in a high-temperature environment. The new steel can be applied to applications requiring nickel-based super alloys at lower costs by reducing alloy materials such as nickel.

- **Development of manufacturing technology for high-strength, non-magnetic retaining rings for power generators**

To improve the efficiency of power generators, large rotor parts that rotate at high speeds are housed in a cylindrical metal case called a retaining ring to prevent them from flying off due to centrifugal force. The retaining ring must have the strength to withstand a large centrifugal force and must be non-magnetic to prevent heat being generated by the eddy current in the magnetic environment. To meet these needs, we developed a special manufacturing technology for high-strength, non-magnetic retaining rings. The technology consists of the optimization of forging conditions and special tools. Moreover, by using our originally developed strength prediction simulator, variations in strength are reduced. This technology is expected to be widely adopted in the future.

(4) Engineering

Engineering R&D focuses on the development of environmental conservation and recycling equipment, and a variety of energy-saving industrial furnaces.

R&D expenditures in this segment during the fiscal year under review amounted to ¥134 million.

- **Further developments of slim batch vacuum-carburizing furnace “SyncroTherm®”**

Vacuum-carburizing equipment uses progressive technologies to possess advanced characteristics and to expand the life of the automatic transmissions or fuel injection components of automobiles. We have incorporated the ModulTherm® technologies from ALD Vacuum Technologies, and the concept of ModulTherm® has been accepted by automotive manufacturers and tier 1 suppliers. Moreover, we have concluded a technical cooperation agreement regarding SyncroTherm® technologies with ALD. We have installed substantiation equipment at the Takiharu Techno-Center (Machinery Division), and have been accepting carburizing trials for a great deal of potential customers.

As a specific result of those developments, we have achieved smaller deformation and higher productivity. We provide highly valuable know-how to our customers - about materials from the R&D Division and equipment from the Machinery Division - and we are able to offer precise solutions for the increasingly sophisticated needs of our customers.

With our product lineup of ModulTherm® for large lots, and SyncroTherm® for small lots, we will reach potential customers in a wide range of fields including automobile manufacturing, construction machinery manufacturing, and industrial machinery manufacturing.