Showa Denko and its Group companies are promoting R&D in line with their medium-term consolidated business plan PEGASUS, allocating resources preferentially to the two business domains of “Energy/Environment” and “Electronics.” We are pursuing our strategy of promoting interconnection of inorganic, metal, and organic chemical technologies, while attaching great importance to marketing activities.

Showa Denko and its Group companies invested ¥21,597 million (US$278 million) in R&D in 2011. A breakdown by segment of R&D efforts and investments during the year is as follows:

**Petrochemicals**

In this segment, we are fully utilizing our proprietary technologies for catalysts, organic synthesis, and polymer synthesis to meet the needs of manufacturers of printing ink, paint, electronic materials, and automotive parts. We are improving the performance of existing catalysts and developing new catalysts for acetyl chemicals and allyl alcohol to further strengthen our proprietary production processes. As for n-propyl acetate, an allyl alcohol derivative used as an environment-friendly solvent, we are continuing steady production and developing new applications. Furthermore, to meet growing demand for allyl ester resin for use in optical materials, we are increasing production efficiency and developing new grades. We are making marketing efforts to develop new applications and to expand markets. In addition to the enhancement of energy efficiency at our ethylene plant through the renovation of naphtha cracking furnaces in 2010 and the improvement of the waste heat recovery system, we are continuing to develop technologies to increase the use of non-naphtha feedstock and enhance the value of cracker products. We are also developing new energy-saving technologies for naphtha cracking and CO2 recovery under national projects for the development of basic technologies for green sustainable chemical processes. Much progress has been made in developing high-performance catalysts for naphtha cracking. As for the CO2 recovery technology, we have started studies in preparation for its commercialization. The Petrochemicals segment invested ¥486 million in R&D in 2011.

**Chemicals**

To quickly meet wide-ranging customer needs, we are developing semiconductor-processing materials, photofunctional materials, solder resists, high-performance gels, organic intermediates, and base materials for cosmetics.

Regarding photofunctional materials that support the production of high-performance LCDs, we are developing a new multifunctional-thiol-based compound for addition to photo-curing resins as well as photo polymerization initiators, while developing markets for these new products. Our new...
multifunctional-thiol-based-compound plant will be completed in May 2012. We are developing functional polymer materials based on our proprietary monomers. Our new solder resist for flexible circuit boards in LCDs and mobile phones has been well received by the market, and we are further developing its applications and new grades.

In high-performance liquid chromatography, we are expanding the variety of liquid chromatography columns. Development is under way for sample-preparation cartridges for the analysis of trace amounts of chemical substances. We are developing organic intermediates for agrochemicals and disinfectants by fully utilizing our position in raw materials. Meanwhile, we are developing new performance chemicals for use as base materials for cosmetics. We are developing new liquid electrolytes best suited for large LIBs for vehicles. In semiconductor processing materials, we are developing chemical mechanical polishing (CMP) slurries for metal polishing at very small line widths, high-purity gases for etching, cleaning, and film deposition, and high-purity chemicals for cleaning agents and solvents. We are also developing charge dissipating agents for electron-beam lithography processes. As part of these efforts, we have developed volume production technologies for high-purity carbonyl fluoride, a cleaning gas with a very low level of global warming potential, and high-purity hydrogen selenide, used as a film deposition material for solar cells. The Chemicals segment’s R&D investment amounted to ¥3,340 million in 2011.

**Electronics**

We are accelerating the development of state-of-the-art technologies to meet the increasingly sophisticated market requirements. As for storage materials, we are continuing to develop new technologies as the world’s largest independent HD media manufacturer. We are producing HD media with higher performance using perpendicular magnetic recording (PMR) technology, which we have commercialized for the first time in the world. At the same time, we are developing shingled write magnetic recording media, the next-generation technology that will further increase recording density, as well as thermal assist recording and bit-patterned media technologies. We are making preparations for commercialization of these new media products. Using PMR technology, we are making commercial shipments of 1.89-inch and 2.5-inch HD media with recording capacity of 220 and 500 gigabytes per disk, respectively, which represented the highest recording capacity for those sizes in December 2011. Also, we started commercial production of 3.5-inch, 1 terabyte-per-disk HD media.

We are continuing to develop LED chips with higher brightness and power. As for indium gallium nitride (InGaN) LED chips, we have developed a proprietary Hybrid PPD™ (plasma assisted physical deposition) process and introduced a 4-inch epitaxial wafer production line based on the process, thereby substantially improving the productivity.

We are developing their applications in LCD backlight, automotive parts, and white lighting. Using our proprietary light emitting layer technology, we have developed aluminum-gallium-indium-phosphide (AlGaInP) LED chips that emit red light with a wavelength of 660 nm, the optimum light for accelerating the growth of plants. These new LED chips have been adopted at various facilities and model plants for growing vegetables in an environment of controlled lighting. As for infrared LED chips, we are developing reflection-type and point-light-source products based on the metal organic chemical vapor deposition (MOCVD) process, in addition to the conventional liquid phase epitaxial process.

In the area of neodymium-iron-boron magnetic alloys, we are meeting market requirements for high-performance magnets through sophisticated casting technologies.
Research and Development

and the better control of alloy microstructures. Furthermore, we are continuing to develop a new composition with lower levels of added dysprosium (a kind of rare metal) that will maintain high levels of magnetic force at high temperatures, to meet the needs of the automobile industry. The Electronics segment invested ¥6,828 million in R&D in 2011.

Inorganics

We are developing materials and applications by fully utilizing our proprietary material/process technologies. We are developing fillers with high heat dissipation and high electrical insulating properties to serve the needs for compact and high-performance electronic and power devices. Meanwhile, a small amount of VGCF-X™ carbon nanotube gives stable electric conductivity to resins. We are therefore developing resin-composite applications, namely, static-free plastic cases for electric/electronic parts as well as automotive parts. Based on our strengths in nanoparticle technology, we are continuing to develop, as part of a national project, a visible-light-responsive photocatalyst for antibacterial/antiviral agents with improved levels of indoor activity. The Inorganics segment spent ¥459 million on R&D in 2011.

Aluminum

We are developing light, strong, and high-performance materials, parts, and products to meet market needs while conducting research on basic technologies pertaining to their production. Utilizing our proprietary pressurized continuous casting technology, pressurized horizontal completely continuous casting technology, and forging technology, we are developing new alloys and products. In the automotive heat exchanger business transferred to Keihin Corporation in January 2012, we promoted the development of new products to reduce environmental impact and innovative heat exchangers based on new types of refrigerants to meet tighter environmental regulations in the future. Results of the latter development efforts have already been adopted commercially in some car models.

In May 2011, we received the 43rd Ichimura Industrial Award from the New Technology Development Foundation for our joint development, with Toyota Industries Corporation, of direct cooling devices for power control units in hybrid cars. In October of the same year, we also received the Governor of Aichi Prefecture’s award for the same accomplishment. Demand for this cooling technology is expected to grow, not only in the area of automotive parts but also in energy-saving devices. Meanwhile, we are improving our die technology for extrusion, forging, drawing, and press working; our process technologies for purification, fabrication, and bonding; as well as our simulation technology for structural and hot fluid studies. The Aluminum segment’s R&D investment amounted to ¥2,077 million in 2011.

Others

As common R&D activities, Showa Denko’s Corporate R&D Center conducts basic research into new areas with a view to fostering new businesses and developing technologies common to different segments. The Analysis & Physical Properties Center and the Safety Evaluation Center support each segment’s R&D efforts by providing expertise in computational science as well as conducting analyses and investigations. In the area of printed electronics, we started developing conductive inks and other materials in cooperation with NovaCentrix, of the United States. R&D expenditures in 2011 in the Others segment and various items, including important themes described on page 17, totaled ¥8,407 million.
Progress in R&D Strategy under PEGASUS

Under the new medium-term consolidated business plan PEGASUS, we are promoting R&D to commercialize new “growth driver” businesses so as to ensure our “Evolution into a Company That Creates Added Value.” We are placing special emphasis on the following four R&D themes, allocating resources preferentially and accelerating the speed of development.

LIB materials
We are continuing to develop and market materials and components that will ensure sufficient capacity, output, life, and low electrical resistance in large LIBs for various types of electric vehicles. We are providing such solutions as SCMG™ graphite anode material, VGCF™ carbon nanotube, SDX™ carbon-coated aluminum foils for cathode collectors, and aluminum laminated films for packaging.

Expand production capacities and develop new products

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<th>Product</th>
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<th>2012</th>
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<tr>
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<tr>
<td>VGCF™</td>
<td>100 t/y</td>
<td>200 t/y</td>
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<tr>
<td>SCMG™</td>
<td>2,000 t/y</td>
<td>3,000 t/y</td>
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<tr>
<td>SDX™</td>
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<tr>
<td>Aluminum laminated films</td>
<td>1.5 times</td>
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<td>Step-by-step expansion</td>
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<tr>
<td><strong>Under development</strong></td>
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<td>Tab lead</td>
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<td>Electrolyte</td>
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<tr>
<td>Binder</td>
<td>Sample shipment</td>
<td>Build a commercial plant</td>
<td>Step-by-step expansion</td>
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SiC epitaxial wafers for power devices
We have realized the commercial production of silicon carbide (SiC) epitaxial wafers with the world’s highest surface smoothness that can be used in switching devices. We are supplying these wafers to device manufacturers on a full scale, maintaining a high market share in the domestic market. To realize the production of wafers with larger diameters, as a member of the R&D Partnership for Future Power Electronics, we are promoting research under the New Material Power Device Project sponsored by the New Energy and Industrial Technology Development Organization (NEDO).

Heat-resistant transparent film
Our pilot plant for heat-resistant transparent film SHORAYAL™ was completed in July 2011, as scheduled. To realize commercialization in the area of sophisticated electronic devices, we are vigorously promoting evaluation by customers of our new materials for optical and display applications. Development of other new film materials is also under way.

Organic EL
We are working to further improve our proprietary device structure and developing organic EL panels for lighting with higher efficiency and longer life.