



Annual Report 2014: Research and Development

Policies and Themes

We have an R&D team of about 860 people constantly at work on product and technology improvements and on laying the groundwork for future business. In fiscal 2014, we invested ¥12.5 billion (US\$121.6 million) in our R&D programs. The goal of our R&D programs is to strengthen our core businesses and to enhance our ability to generate tomorrow's products today. To stay on the leading edge in our fields of interest, we also do joint research with external research facilities, at universities and other educational institutions, and at public research laboratories. Internally, we encourage collaboration to maximize organizational resources and generate synergies.

Our R&D oversight organization comprises various committees responsible for distinct research themes. They also drive the commercialization of new products and technologies. To ensure balanced oversight, representatives from our business units, laboratories, and strategy divisions sit on these committees. The committees determine the most promising strategies for Tosoh's businesses while considering the Tosoh Group's social responsibilities and environmental policies.

Tosoh concentrates its R&D resources on life sciences, energy and environmental conservation, and electronic materials. R&D departments within our business groups improve and expand applications for their group products. And our main R&D operations conduct programs to cultivate new products and markets.

A primary mission of our life sciences R&D work is to provide developed and developing economies access to high-end diagnostics and biopharmaceutical technologies. Our bioscience R&D themes revolve around separation technologies and immunoassay and genetic testing reagents. We are in particular devoting resources to an emerging Tosoh strength in protein modification technology.

Our R&D in energy and environmental conservation emphasizes themes related to shifts in the chemical industry driven by public opinion and regulation. Specifically, our R&D programs focus on high market growth potential rechargeable lithium-ion batteries (LIBs), catalysts and chelates for removing harmful substances, and solar power materials.

Dramatic advances in semiconductors and consumer electronics dictate our electronic materials R&D programs. We are researching and developing technologies and materials for photomasks and substrates, thin layer deposition, solar power, and electronic displays to keep abreast of and to foster further evolution in the semiconductor and consumer electronics industries.

Among our most important emphases in R&D is how to combine the strengths of our diverse R&D operations for optimum results. We continue to examine methods of integrating R&D thematically and of improving collaboration in R&D generally. Recently, we forged an organization-wide organic electroluminescence materials R&D project.

R&D is about people. And we nurture the scientific and leadership skills of our R&D personnel. About five years ago, we introduced a management of technology (MOT) program to develop our R&D managers. A similar program fosters today's researchers at Tosoh. We also hold events to encourage cohesion among our research staff and provide opportunities for our R&D people to network and exchange information.

Specialty Group

Tosoh's functional materials R&D yields products to meet society's pressing needs in cutting-edge environmental stewardship, health care, and electronics technologies.

It contributes to highly efficient, reasonably priced solar power generation. Our solar power R&D encompasses physical vapor deposition (PVD) materials for both thin film silicon and copper indium gallium selenide (CIGS) photovoltaic cells. Its various programs yield increasingly efficient materials and technologies, such as transparent conducting oxide (TCO) sputtering targets that achieve higher photovoltaic cell efficiency than standard targets.

Our R&D on sputtering targets supports manufacturing technologies for semiconductors and flat-panel displays. We've achieved sputtering targets for the manufacture of the thin film transistor oxide semiconductors used in flat-panel displays and for the low-temperature, low-resistance thin film used in increasingly popular touch-panel displays. Following our commercialization of electron transport materials, we began producing the high-efficiency electron hole transport materials used in organic light-emitting diode (OLED) displays. We also are developing, among other materials, organometallic compound materials for the next generation of miniaturized circuits.

Our energy and environmental conservation R&D contributes especially to the automotive industry. It has produced groundbreaking work on zeolites for automotive catalytic converters. And it continues to develop improved manganese oxide materials for use in the cathodes of the rechargeable LIBs popular in electric vehicles and other applications.

Tosoh's eco-products, meanwhile, are the result of ongoing R&D to improve the company's heavy metal chelating. We recently produced an agent for removing anionic heavy metals, such as hexavalent chromium, that complements our line of cationic heavy metal chelates.

Tosoh's vision of its role within the global health care industry is to support better medical care in developing and developed countries for infectious diseases, cardiovascular diseases, cancer, and diabetes. We strive to put

advanced medical diagnostic systems into the hands of medical caregivers and researchers. Our R&D has made particular progress in developing diagnostic tools for infectious diseases. Tosoh's molecular testing systems for tuberculosis, for example, are exponentially faster than traditional methods.

As well, our R&D efforts have produced zirconia dental materials that are contributing to better treatments in dentistry.

Our biomedical R&D yields the high-performance separation media essential for analysis and purification. Tosoh's strengths in protein modification technology are growing, particularly in the purification technologies for the human-derived proteins used in leading-edge antibody drug development and early-stage cancer testing technology.

Chlor-alkali Group

R&D innovations in electrolysis and other technologies strengthen the vinyl isocyanate chain at the core of Tosoh's business in basic chemicals.

Tosoh uses n-BiTAC bipolar ion-exchange membrane electrolyzer cells for electrolyzing salt. They represent the first link in the company's vinyl isocyanate chain and are the best of their kind in electrical efficiency. Tosoh R&D continues to develop and test cathodes that likewise conserve power.

Tosoh's R&D operations work to develop technologies to improve vinyl isocyanate chain manufacturing, from catalyst development through process improvement and debottlenecking.

In managing the integration of the vinyl and isocyanate components of the chain, moreover, Tosoh and NPU collaborate on developing or reengineering processes. Their joint efforts boost yields and heighten the efficiency by which the raw materials and intermediates shared by the plants are used to produce vinyl products and, in the case of NPU's isocyanate chain, methy diphenyl diisocyanate (MDI), hexamethylene diisocyanate (HDI), and other urethane-based products.

The R&D organizations of Tosoh and NPU play important roles in developing technologies and products to support NPU's efforts to improve its cost efficiency and expand its product lines. NPU's products range from polymeric and monomeric MDI to higher-value-added products, such as HDI, liquid polycarbonate diol (PCD), and thermoplastic polyurethane (TPU) elastomer.

R&D at Tosoh and NPU underpins NPU's installation of a low-cost MDI production system and efforts to improve the color and quality characteristics of monomeric MDI to support a higher price structure. Tosoh and NPU also cooperate in R&D to develop applications for heat-resistant polyurethane foam used in the construction industry and for other urethane-based products.

Petrochemical Group

Tosoh's R&D in petrochemicals adds value to commodities. Its purpose is primarily to improve and develop polymers and related technologies. The company's research, development, and improvement program for commodity polyethylenes differentiates Tosoh's products with superior functionality. New and better grades of foams, laminates, food product packaging, and other products contribute to our Petrochemical Group's sales.

Our petrochemicals R&D results in new applications for our high melt elasticity polyethylenes for use in the automotive, packaging, construction materials, and medical care industries. Recent developments include high melt strength polyethylene (HMS-PE) suitable for use in medical unit-dosage dispensers for eyedrops and other medicines and in medicine bottles and ampoules.

R&D in petrochemicals contributes to the photovoltaic cells market through Tosoh's high-performance ethylene vinyl acetate (EVA) sealing film. Tosoh is one of only a few companies worldwide making grades of EVA suitable for the encapsulant film of photovoltaic cells. And our researchers are developing highly durable EVA-based adhesives.

The supply of raw materials for petrochemical resins provided by C5 and C9 fractions is becoming an issue in the petrochemical industry because of the decline in the operating rates of naphtha crackers. Consequently, Tosoh's researchers are concentrating on developing manufacturing technologies that substantially improve the production volume of naphtha crackers.

The company's high-performance resins lineup benefits from R&D that has led to polyphenylene sulfide (PPS) resins with superior metal bonding and high thermal conductivity characteristics. Our metal adhesion PPS compounds are popular in the electronics industry. Commercial applications of PPS resins are available for smartphone bodies and for LED lighting parts. We also are developing materials that resist the surface degradation common in insulation materials.

Petrochemicals R&D also has resulted in reengineering our chloroprene rubber (CR) manufacturing processes to expand CR production and in developing new grades of CR in accordance with customer requirements. Similarly, we are working to improve our production processes for chlorosulphonated polyethylene (CSM) rubber and to develop new CSM grades to support our position as the world's top CSM manufacturer.

Much of Tosoh's R&D in petrochemicals involves discovering new applications for products and developing new products for those applications. We are looking into uses for PVC paste besides wallpaper and flooring materials. And we are aggressively developing polymer materials for use in optical materials for LCDs and in substrate materials for flexible displays. We recently developed Tosoh HMS, a new functional polymer with application in displays. Tosoh HMS boasts superior optical properties and heat resistance.

Engineering Group

The R&D Center of our subsidiary Organo Corporation forms the core of Engineering Group R&D. That facility emphasizes developing basic technologies, improving products, and devising new products and services to complement and bolster Organo's offerings. These include development on water treatment equipment, such as pure, superpure, and clean water producing equipment; water treatment plants, such as wastewater treatment or chromatography separation systems; water treatment chemicals; and food additives and materials for food processing.