Environmental Impact and Resource Reduction, and Climate Change Countermeasures

Climate Change Countermeasures

FY : Fiscal Year means the year ending March 31.
For example, FY2016 means April 1, 2015 - March 31, 2016

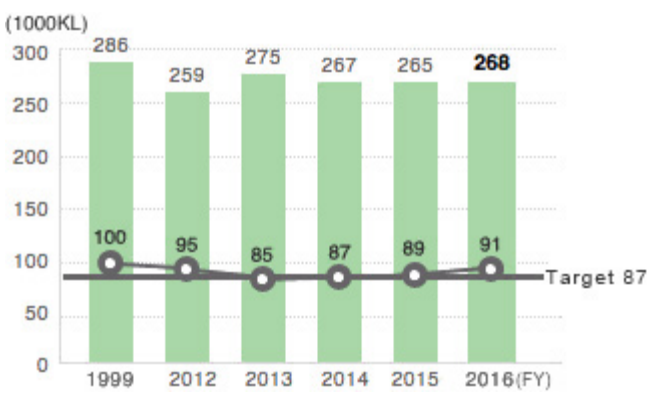
1. Energy Consumption

JSR's Responsible Care Committee adopted a medium-term Independent Environmental Preservation Plan. This plan contains per-unit targets for energy reduction, which serve as measures to help prevent global warming. In order to reach these targets, JSR is engaged in E-100 Plus project activities targeted at reducing energy and resource use. However, we were unable to meet our per-unit energy reduction targets in FY2016 due to production decreases and other factors. JSR remains committed to energy conservation activities and will continue to work toward reducing energy consumption.

(1) Energy Reduction Targets

1. The annual per-unit energy consumption was reduced by approximately 1% based on standards created in FY1999. (Independent standard based on regulations concerning the rational use of energy) (This level has been maintained and managed since FY2013)
2. Improvements in average per-unit energy consumption in the most recent 4-year period (from FY2017)

(2) Energy Consumption (Crude Oil Equivalent)*1 and Per-unit Index*2



*1 Although data in the Ministry of Environment guidelines are presented in joules, this report uses the crude-oil equivalent as per the Law Concerning the Rational Use of Energy.

*2 FY1999=100
[(energy consumption of fiscal year)/(annual production volume for fiscal year)]/[(energy consumption for FY1999)/(production volume for FY1999)]x100

2. Initiatives to Reduce Greenhouse Gases

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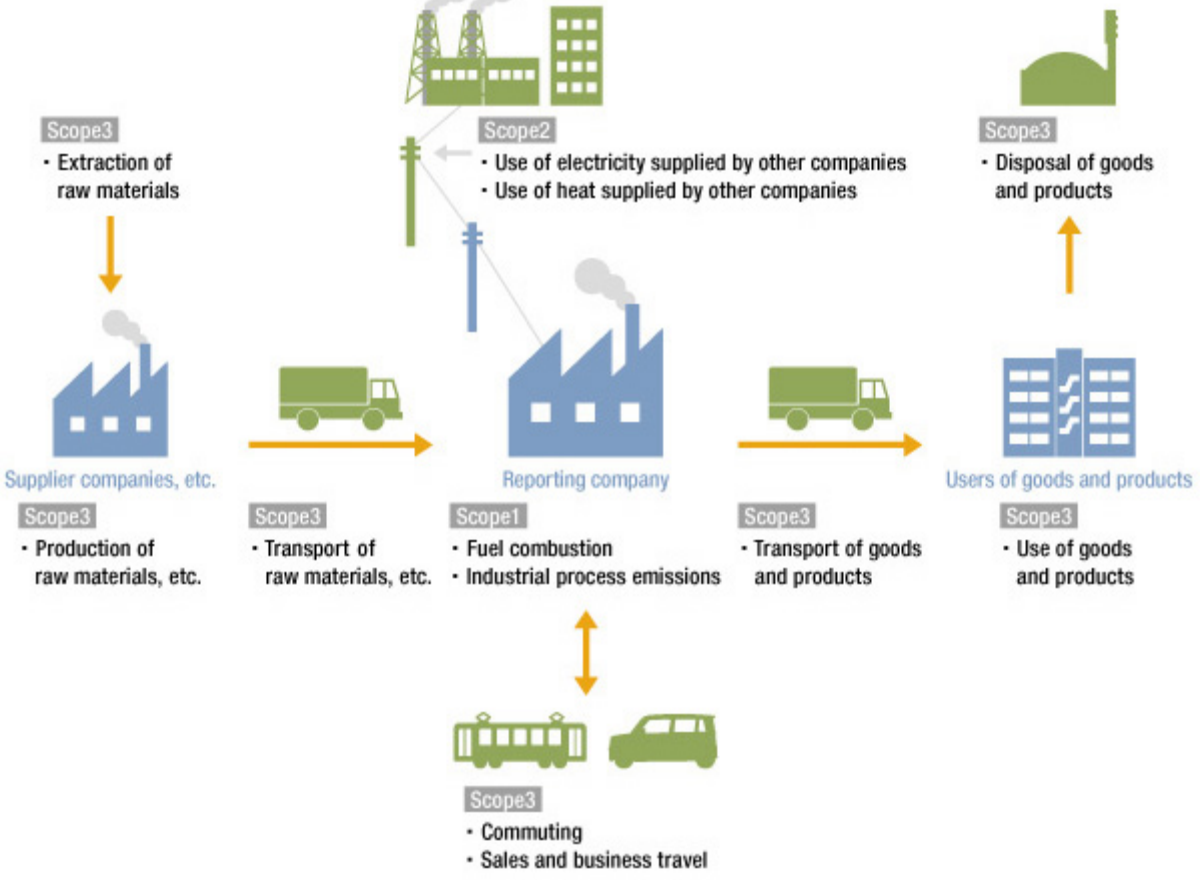
With increasing moves in recent years by businesses to manage greenhouse gases indirectly emitted from their supply chains and disclose their emissions at the global level, JSR has launched initiatives based on the Basic Guidelines on Accounting for Greenhouse Gas Emissions Throughout the Supply Chain issued by Ministry of the Environment, Government of Japan.

Scope1 : Direct greenhouse gas emissions by sources owned or managed by a company or household (use of fuel: factory, heater, private automobile, etc.)

Scope2 : Indirect emissions from the use of electricity, steam, or heat (use of purchased electricity, etc.)

Scope3 : Other indirect emissions besides Scope 2.
("Company" includes the procurement of raw materials, employee business trips, subcontracting of waste disposal, etc.
"Household" includes the purchase of products, travel, subcontracting of waste disposal, etc)

Scope of Greenhouse Gas Emissions from Businesses (conceptual illustration)



(1) Accounting for Greenhouse Gas Emissions Throughout the Value Chain

Category		FY2015 emissions		FY2016 emissions		Emissions subject to calculation
		CO_2 (t)	Percentage (%)	CO_2 (t)	Percentage (%)	
I. Direct emissions (Scope 1)		397,548	56.5	379,019	54.8	■Direct emissions from the use of fuel and industrial processes by the reporting company
II. Energy-derived indirect emissions (Scope2)		261,351	37.2	272,225	39.3	■Emissions from the use of electricity and heat purchased by the reporting company
III. Other indirect emissions (Scope3)		44,219	6.3	40,597	5.9	
Other indirect emissions (breakdown of Scope 3)						
Category 1	Purchased goods and services	-	-	-	-	Emissions from activities up to the manufacture of raw materials, parts, purchased goods, sales-related materials, etc. - Not calculated.

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Category 2	Capital goods	-	-	-	-	Emissions from the construction and manufacturing of the reporting company's capital goods - Not calculated.
Category 3	Fuel and energy related activities not included in Scope 1 or 2	10,273	23.2	6,551	16.1	Emissions from the procurement of fuel used in power generation, etc., for electricity and heat procured from other entities
Category 4	Transportation and distribution (upstream)	12,028	27.2	12,172	30.0	(1) Emissions from the distribution of raw materials, parts, purchased goods, sales-related materials, etc., up to delivery to the reporting company (2) Emissions (emissions from the distribution paid for by the reporting company) amount of activity from distribution services other than (1) above (transport, handling, and storage) purchased in the fiscal year of the report: Amount of domestic and overseas shipment distribution
Category 5	Waste generated in operations	8,569	19.4	9,343	23.0	Emissions from the transportation and processing of waste generated by the reporting company
Category 6	Business travel	321	0.7	327	0.8	Emissions from employee business travel
Category 7	Employee commuting	1,159	2.6	1,182	2.9	Emissions from employee transportation when commuting to and from the place of business
Category 8	Leased assets (upstream)	43	0.1	47	0.1	Emissions from the operation of assets leased to the reporting company (excluding emissions calculated under Scope 1 or 2)
Category 9	Transportation and distribution (downstream)	11,770	26.6	10,916	26.9	Emissions from the transport, storage, cargo handling, and retail sales of products (limited to those items not paid for by the reporting company)
Category 10	Processing of sold products	-	-	-	-	Emissions from the processing of intermediate products by the reporting company - Not calculated.
Category 11	Use of sold products	-	-	-	-	Emissions from the use of products by users (consumers and companies) - Not calculated.
Category 12	End-of-life treatment of sold products	-	-	-	-	Emissions from the transportation and processing of products upon disposal by users (consumers and companies) - Not calculated.
Category	Leased assets	56	0.1	59	0.2	Emissions from the

13	(downstream)					operation of assets leased to other entities
Category 14	Franchises	0	0.0	0	0.0	Emissions from franchises - No emissions; business structures are not franchises.
Category 15	Investments	-	-	-	-	Emissions related to the management of investments - Not calculated.
Scope 3 total (Categories 1 through 15)		44,219	100	40,597	100	

(2) Actions for Scope 1

JSR set a CO_2 emission reduction target under the Medium-Term Independent Environmental Preservation Plan and is striving to meet this target through various energy saving activities.

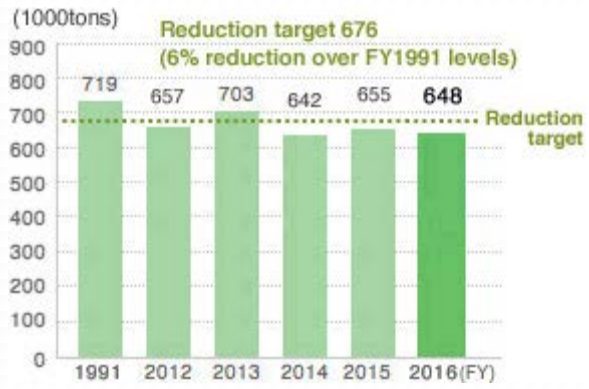
1. CO_2 Reduction Targets and Current Emissions

CO_2 Emissions Reduction Target

Reduced the total CO_2 emissions from JSR 's three plants by 6% in total compared to FY1991

Review of CO_2 reduction targets with regard to the Paris Agreement (FY2017)

CO_2 Emission (JSR's three plants)



In FY2013, JSR established its "System to Reduce Total CO_2 Emissions from Three plants by 6% Compared to FY1991" by upgrading its energy-saving technologies through the introduction of fuel conversion at the Kashima Plant (Kashima South Joint Power Corporation) and a sludge dewatering system at the Yokkaichi Plant. In FY2016, JSR successfully reduced CO_2 emissions by approximately 9.5% over FY1991 levels to achieve the reduction target. The per-unit index was 65 in FY2016, which represents a continuing decrease in comparison with FY1991 on a scale of 100.

2. Examples of Measures Taken to Reduce CO_2 Emissions

Example 1: Introduction of a natural gas-fired turbine cogeneration system

The Yokkaichi Plant installed a natural gas-fired turbine cogeneration system in April 2010. By using natural gas instead of coal, a heavy oil-fired steam boiler and condensing steam turbine system, this new system helped us to cut CO_2 emissions by approximately 38,000 tons in FY2016.

Natural gas-fired turbine cogeneration system (Yokkaichi Plant)

Example 2: Introduction of a sludge dryer system that makes sludge combustible

In FY2013 a sludge drying system was adopted at the Yokkaichi Plant in order to dry the sludge generated from its general wastewater treatment facility. Previously, sludge containing a high percentage of water was burned with combustion

support fuel (heavy oil); but drying allows us to use the sludge itself as fuel, which in turn allows us to reduce the amount of combustion support fuel we use. This led to a reduction in CO_2 emissions of approximately 1,100 tons in FY2016.

Sludge dryer system (Yokkaichi Plant)

(3) Actions for Scope 2

1. Measures to Cut Power Consumption at the Head Office

Power Saving Target for the Head Office

8% reduction compared to the average power consumption from the base years of FY2010 and FY2011

Major Efforts

- Policy of turning off lights and office equipment such as printers when not in use
- Implemented the so-called "Cool Biz" dress code.
- Changed work schedules so that employees begin work and return home earlier than usual two days per week from June to September.
- Maintained a proper air-conditioned room temperature that achieves a balance between energy savings and operational efficiency.

The Tokyo Metropolitan Government requires major tenants of a building occupying 5,000 square meters or more in floor area or consuming six million kWh or more of electricity annually to reduce its CO_2 emissions under the Tokyo Metropolitan Ordinance on Environmental Preservation.
Although we are not subject to this obligation, we are promoting energy conservation on our own initiative by voluntarily setting a specific power saving target.
In FY2016, as a result of these efforts, our power consumption decreased by 21% over the average consumption of the base years.

Power Consumption at the Head Office

(4) Actions for Scope 3

1. Environmental Measure in Logistics: Improving Transport Efficiency

As part of our environmental efforts in transportation, we have taken systematic steps to reduce our energy use as a designated shipper under the FY2007 amended Energy Conservation Law. We are working to reduce per-unit transport energy by an average of at least 1% per annum by using larger tanker trucks, and by shifting from road to rail and water transport.
In FY2016, as a result of new policies to transport goods and raw materials by railway and ship, modal share improved 1% over the previous fiscal year, which led to a reduction of 1% in per-unit transportation energy over the previous year.

Transport Statistics

FY	2012	2013	2014	2015	2016
Transport volume (million ton-	473	471	492	523	511

kilometers[*3])					
Rail/Sea transport ratio (%)	83	82	83	85	86
Energy consumption level (kiloliters: converted to crude oil)	8,726	8,655	9,026	9,388	9,112
Energy per-unit (kiloliters/1,000 ton-kilometers)	0.0184	0.0184	0.0184	0.0180	0.0178
CO_2 emission level (tons)	22,218	21,907	22,960	23,984	23,333
- Transportation and delivery of raw materials and other materials (tons)	10,294	9,686	10,489	12,028	12,172
- Transportation of waste from plants (tons)	219	175	164	186	245
- Transportation and delivery of products (tons)	11,705	12,046	12,307	11,770	10,916

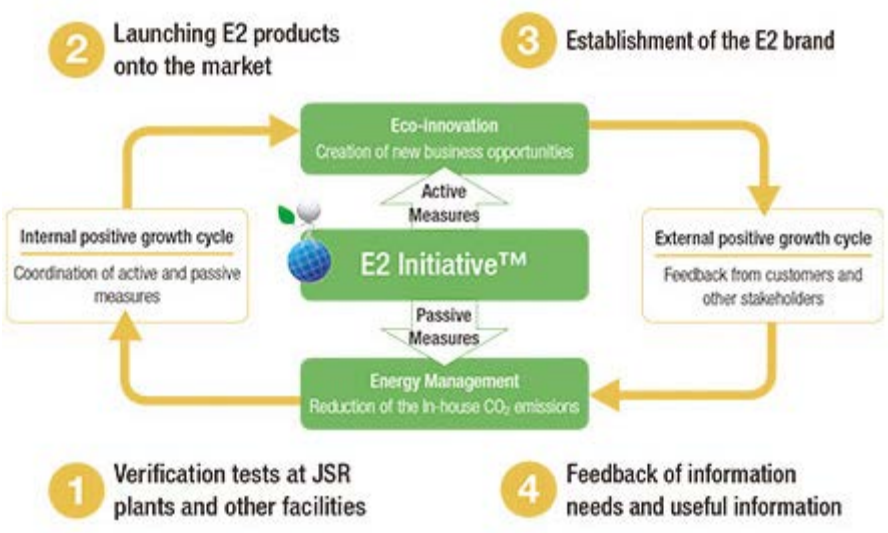
*3 Ton-kilometer: Freight Tonnage (Ton) x Transport Distance (km)

3. E2 Initiative™

The JSR Group's "E2 Initiative™" is an "environmental value creation" concept that provides clarification on what we need to keep in mind as we manufacture our products and develop our business. It is also used as a concept that allows us to work toward solving problems related to energy, resources, and climate change as we carry out our business activities.

(1) Working to Solve Environmental Issues through the Deployment of E2 Initiatives™

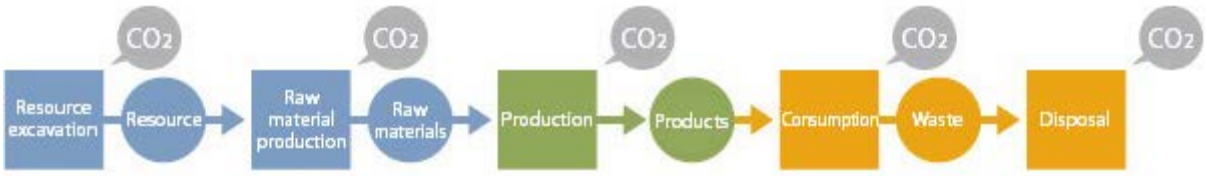
Because both humans and a large number of other living things share the Earth and its resources, we must make an earnest effort to tackle environmental issues. The JSR Group has adopted its E2 Initiative™ as a concept to simultaneously reduce its environmental impact and create new business opportunities through environmentally friendly products.
The E2 Initiative™ is based on "Eco-innovation," which is designed to create business opportunities based on the environment, and Energy Management, which is focused on reducing CO2 emissions. It is a concept that allows us to create value both in active and passive ways. As we have shifted our concept of value from the conventional two approaches of differentiation and cost, our new concept of environmental performance has become essential.
By using Lifecycle Assessment (LCA) to evaluate the environmental impact of our products from the design stage in product development to the use of the product, we are working to solve environmental problems throughout business operations.



(2) LCA & LCI Initiatives

LCA (Life Cycle Assessment) is a method of quantitatively assessing environmental impact throughout the lifecycle of each product, from the materials procurement

stage to manufacturing, sales, use, and disposal.

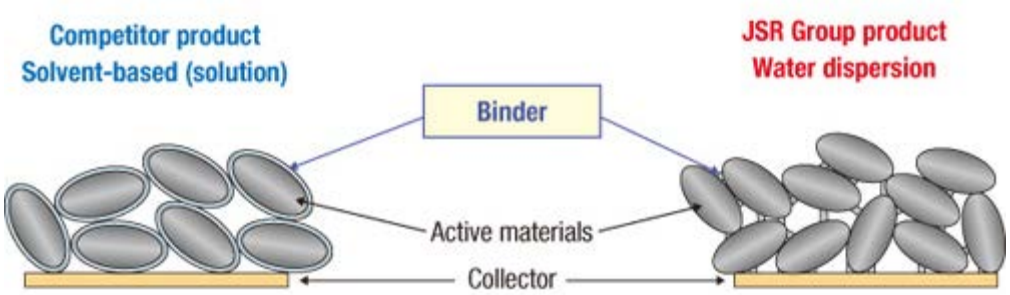


Implementation of LCA requires that we calculate the amount of resources used when manufacturing a product and the amount of CO2 emissions during all stages of the lifecycle of a product (LCI data).
The entire synthetic rubber industry, including the JSR Group, has engaged in LCI data calculations for representative synthetic rubber products.
The results of these calculations are stored in a database maintained by the Japan Environmental Management Association for Industry LCA Forum. For LCI data of our fine chemical products, we keep track of the amount of CO2 produced during the production.
We have started to apply LCA from the R&D stage and to operate a system of developing product designs with consideration for CO2 emissions. We have made trial LCA calculations for approximately 104 product groups (159 representative grade types) as of March 31, 2016.
We continue to make LCA calculations for newly developed product groups and grades.

(3) Development of Environmentally Friendly Products (Current E2 Initiative)

1. Electrode binders for lithium-ion secondary batteries as part of our efforts to create a low-carbon society

The JSR Group offers electrode binders (adhesive) for lithium-ion secondary batteries. These binders have experienced an increase in demand due to efforts for the effective use of energy and the creation of a low-carbon society.
Lithium-ion secondary batteries are used in hybrid and electric vehicles. As with normal dry-cell batteries, these batteries have positive and negative electrodes. These electrodes are made by bonding carbon materials or metal oxide particles, which function as the activating material, to copper or aluminum foil (collector). Binders provided by the JSR Group are used in this binding process.
JSR Group binders are made by dispersing resin in water, which has a low environmental impact. This point bonding method also significantly reduces the bonding area of the resin that interferes with the electrical continuity of the active substance. This results in the creation of electrodes with low electrical resistance.



Water dispersion enables low electrical resistance via point bonding.

These electrodes demonstrate the superior performance of JSR Group polymer design technologies, water dispersion technologies, and battery performance evaluation technologies.
Not limited to electric vehicles, our materials are used in a wide variety of products including computers, cellphones, electric vacuum cleaners, and so on.

2. Lithium-ion capacitors that help achieve efficient energy use

Lithium-ion capacitors, which the JSR Group positions as one of its strategic businesses in the JSR2016 mid-term business plan, are an electricity storage device capable of instant charging and discharging together with a long lifespan and little propensity for self-discharge. They are currently at the center of global attention as a key technology for the more efficient use of energy, and their market is expected to expand significantly.
JM Energy Corporation, the industry's leading company, commenced the world's first high volume production of lithium-ion capacitors at the end of 2008. The company's current aim is to develop and offer lithium-ion capacitors with higher performance by utilizing the JSR Group's material and precision processing

technologies to expand their applications to various fields.

JM Energy Corporation ULTIMO™ brand of lithium-ion capacitors

Laminated cells

Laminated-cell modules

Laminate cells are thin, lightweight, compact, and have excellent heat radiation. Due to their ease of installation, they can be used in a wide range of applications. A module is a package of multiple cells.

Square cells

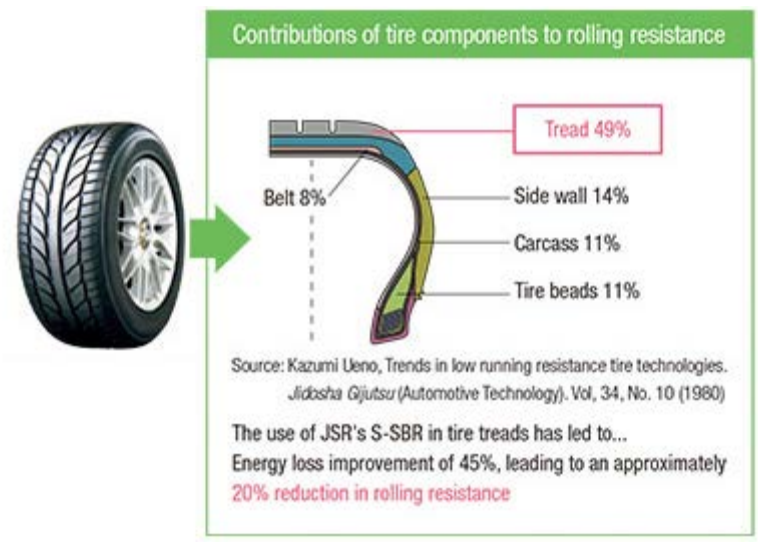
Square-cell modules

Robust can-type modules. JM Energy adopted the world's first prismatic can structure as an alternative to the more common cylindrical structure. These modules excel in heat radiation efficiency and ease of implementation.

3. S-SBR technologies have great potential to help mitigate climate change

Fuel-efficient tires are environmentally-friendly products and yet maintain their ability to stop safely and securely. The JSR Group's solution polymerization SBR (S-SBR) has received positive feedback from customers. The JSR Group designed S-SBR using technology that more readily facilitates rubber molecules and tire reinforcing material molecules to bond tightly, which reduces internal friction and rolling resistance[*4]. In addition, this is achieved without changing the characteristics of rubber that enable tires to stop. S-SBR allows large reductions in environmental impact through the entire lifecycle of the tire, from the material selection and its usage to disposal.

Automobiles will still require tires even after automotive engines are replaced with electric motors. Thus, demand for S-SBR is high both in countries and regions where environmental standards are high, such as Japan and Europe, and in emerging nations where reducing environmental impact is an urgent issue. These tires are currently manufactured at the Yokkaichi Plant in Japan and at JSR BST Elastomer Co., Ltd. in Thailand. We are also considering production operations in Hungary. These global deployments are being undertaken in anticipation of market expansion in 2020. They are carried out based on our supply chain management concepts, which are designed to ensure that production takes place in locations close to markets, ensuring stable material procurement so that the impact due to logistics can be reduced and a stable supply of product can be ensured. By meeting the global demand for fuel-efficient tires using the E2 Initiative™ concept, we will contribute to solving global environment issues.



*4 Rolling resistance: Resistance in the direction opposite to the direction of tire rotation. Caused by tire deformation, ground contact friction, and air resistance.

4. CALGRIP™ brand of latent heat storage materials contributes to energy conservation

Latent heat storage material CALGRIP™ is a material that is able to maintain a specific

temperature between -20 and +80°C over long periods of time. CALGRIP™ is utilized in fields that require energy saving or accurate temperature control such as the transportation and storage of pharmaceuticals and foods, building materials, and air conditioning.
The product was used in next generation energy-saving model houses developed by the University of Tokyo and Chiba University and exhibited at the "ENEX2014/Smart Energy Japan 2014" exhibition held at Tokyo Big Sight. In the University of Tokyo's model house, CALGRIP™ was installed in the ceilings and floors, storing solar radiation heat during the daytime and discharging it during the night to maintain a comfortable room temperature even in the winter. CALGRIP™ contributes to the reduction of energy consumption by minimizing the use of air conditioners/heaters.

Next-generation housing developed by the University of Tokyo (CALGRIP™ used in ceilings and floors)

CALGRIP™ being installed in ceilings

5. SIFCLEAR™ brand of water-based, stain-resistant, and durable emulsion materials contribute to energy conservation and environmental impact reduction

SIFCLEAR™ is used in paints to make them resistant to contamination, helping maintain cleanness in appearance over the long-term. The high durability of the paint film reduces the need for frequent re-painting, contributing to resource conservation. In particular, when used in heat reflection paints, heat reflection effect is maintained over the long-term, achieving significant energy savings. It is also attracting attention as an environmentally-friendly material because of its ability to prevent Volatile Organic Compounds (VOCs) and the generation of odor.

SIFCLEAR™ is used in black portions of the walls of the Yokkaichi Plant Main Building

SIFCLEAR™ is used on the right butadiene tank at the Kashima Plant

Painted with highly durable stain-resistant paint that contains SIFCLEAR™ (Photo courtesy of SHOCHIKU, Co., Ltd. and Kabuki-za Co., Ltd.)

6. The BIOLLOY™ brand of plant-derived materials

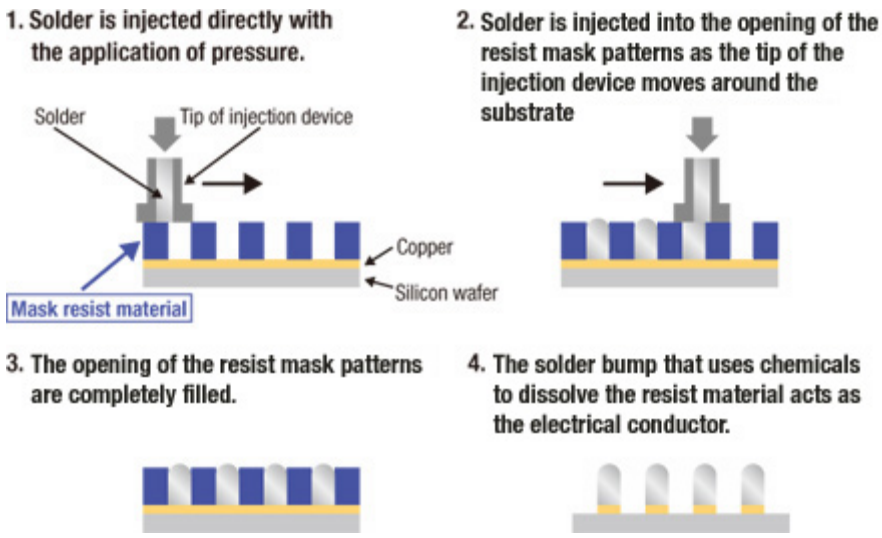
BIOLLOY™ is a bioplastic produced by combining a thermoplastic resin with plant-derived polylactic acid. Compared to existing general bioplastics, BIOLLOY™ has five times greater shock resistance. The product is expected to be used in containers for cosmetics, shampoos, and other products that require thin, light, and eco-friendly materials, as well as in various other applications including automotive interiors, office automation equipment, and household appliances.

(Top) Colored BIOLLOY™ pellets (Bottom) Bottles that contain BIOLLOY™

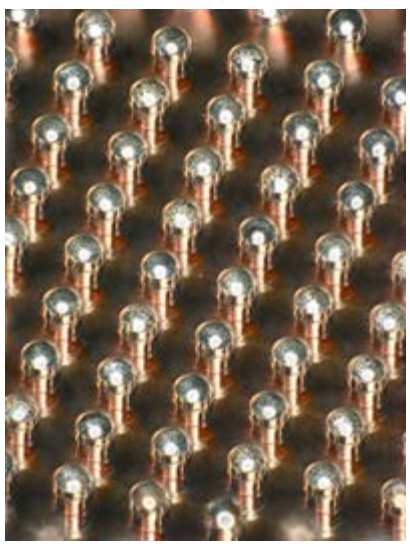
7. Mask resist material[*5] for injection molded solder processes that significantly simplifies processing and reduces environmental impact

As the miniaturization of transistors and wiring in IC chips continues to advance, demand for high-performance equipment used to build IC chips during semiconductor mounting processes continues to increase. JSR, IBM Japan, and Senju Metal Industry Co., Ltd. have worked together to develop a revolutionary injection molded solder (IMS) process that enables advanced high-density semiconductor mounting processes.

IMS is a technology in which a specialized soldering device directly injects solder into the opening of mask resist material formed on substrates. The mask resist material developed by JSR can resist temperatures up to approximately 250°C, which is the temperature at which solder is used. This enables extremely fine solder bump[*6] patterns of 30 microns to be formed anywhere on substrates. This eliminates the significant amount of plating required with conventional electrodeposition methods, the corresponding maintenance, and the large amount of waste disposal. With a 100% utilization ratio of solder, this environmentally friendly process generates zero process inefficiency and reduces waste products. In comparison with conventional methods, this method simplifies processes and has low environmental impact, and so we hope that this method will be utilized more and more.



Solder bump forming process using injection molding



Finished solder bumps (bump diameter: 50 microns)

*5 Mask (photo) resist material: Resin for which solubility changes with light. Patterns can be formed by applying this material to wafers and then exposing it to light and developing it with chemicals. This material protects the wafer surface.

*6 Bump: A protrusion of solder that acts as an electrode to electrically connect the semiconductor device to the substrate.

8. HUSHLLOY™ reduces squeak noise, grease application, and non-woven fabric lamination

HUSHLLOY™[*7] is an innovative material designed to reduce squeak noise caused by plastic joints in vehicle interiors. Conventionally, squeak noise prevention is achieved by applying grease or attaching felt fabric to the components, but the use of HUSHLLOY™ has made these countermeasures unnecessary, allowing the component manufacturers to shorten their production process. In addition, since the material itself has the effect of minimizing squeak noise, maintenance is not required for a longer period of time.

*7 HUSHLLOY™ is a registered trademark of TechnoPolymer Co., Ltd.

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