

New Value Creation through Green Innovation



Our role is to fully utilize wood resources effectively to solve social challenges

Oji Holdings Corporation
Corporate Officer
General Manager,
Innovation Promotion Div.

Kohei Michikawa

Under the Group basic policy of “Initiatives for Product Development—Green Innovation—,” our Innovation Promotion Division aims to grow healthy forests, create products that utilize those forest resources, and deliver them to society. We are promoting research and development focusing on three themes to solve social issues by making full use of wood resources and refining various core technologies cultivated through forestation and papermaking over the 150 years since the company's founding.

First, in the area of new materials derived from wood, we are developing new materials with the aim of creating new value for pulp and venturing into new businesses. Specifically, we are compounding cellulose nanofibers (CNF) with natural rubber and exploring the possibility of new applications for this composite material. Further, we are promoting the development of products such as cellulose mats and cellulose polymer pellets to make effective use of cellulose materials. We are also manufacturing sugar solution from wood that will become a key raw material for a variety of biomanufacturing in test basis. By combining it with fermentation, we will be able to convert this sugar solution into polylactic acid and other biomass plastics and into ethanol, which is expected to become a raw material for sustainable aviation fuel (SAF), with the aim of decarbonization.

Next, in the area of medical and healthcare, with an eye on the medical care of the future, we are expanding our business into new fields. We are working on the development of phar-

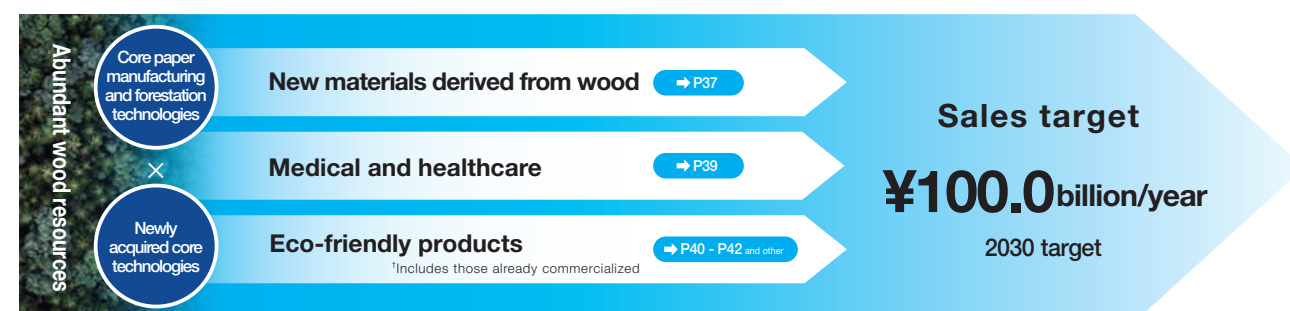
maceutical products using hemicellulose, a main component of wood, and large-scale cultivation of medicinal plants for the stable supply of high-quality, domestically-grown raw materials for Chinese herbal medicines. In addition, we are promoting the development of cell culture substrates for controlled cell orientation, which are expected to have applications in regenerative medicine.

In the area of eco-friendly products, we are developing products to meet a wide variety of needs for solutions to environmental issues, such as reducing plastic consumption. Specifically, we are manufacturing biomass plastic films for packaging applications with the aim of reducing carbon emissions derived from fossil fuels. In addition, we are developing recycling-friendly paper products and composites of biodegradable plastics and cellulose. We also have developed functional products such as anti-heat windshield films to reduce the burden on the global environment.

Further, with the aim of accelerating our green innovation and steadily growing it into a pillar of earnings, we have established the Corporate Business Development Division, and based on the technologies developed in the Innovation Promotion Division, we are promoting the commercialization of liquid packaging cartons, including the development of plastic-free products.

With the promotion of these kinds of new value creation through green innovation, our target is net sales of 100.0 billion yen by 2030.

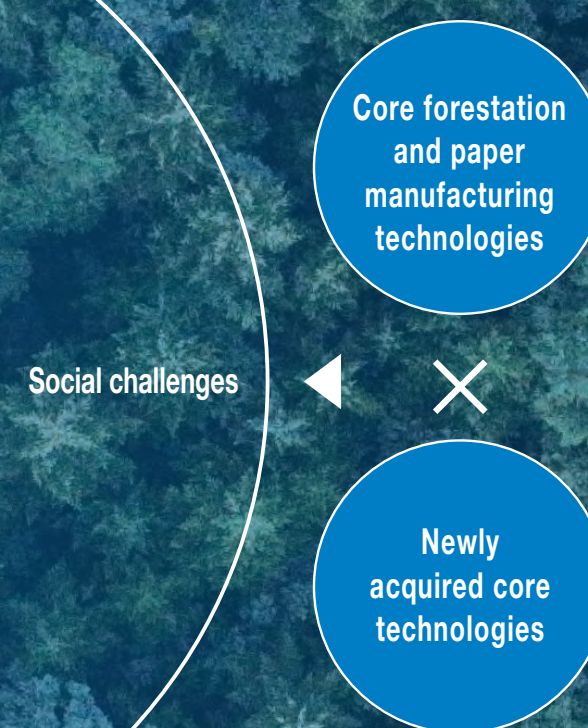
Future Green Innovation Initiatives



Innovation Promotion Division's Initiatives Using Our Abundant Wood Resources

The Innovation Promotion Division is making use of our abundant wood resources and various core technologies to contribute to the Oji Group's green innovation.

In addition to the core technologies that we have acquired in our paper production business, including forest tree breeding technology, pulping technology, paper manufacturing technology, and water treatment technology, we are acquiring core technologies that differ from conventional paper production industry technologies, such as wood component refining technology, nano-fibrillation technology, enzymatic and fermentation technologies, and nanostructure processing technology, and promoting the development of new materials derived from wood, medical and healthcare products, and eco-friendly products.



Various core technologies

Forest tree breeding technology	Pulping technology
Paper manufacturing technology	Coating technology
Corrugated container converting technology	Lamination technology
Non-woven fabric manufacturing technology	Adhesive processing technology
Water treatment technology	Film forming technology
Wood component refining technology	Precise pulp-molding technology
Nano-fibrillation technology	Fibrillation and mixing technology
Enzymatic and fermentation technology	Chemical synthesis technology
Polymerization technology	Nanostructure processing technology

Creating new value for pulp

New materials derived from wood

→ P37 → P38

- Sugar solution
- Ethanol
- Biomass plastics
- CNF (Cellulose nanofiber)
- Cellulose polymer pellets
- Cellulose mats

Challenge to a new field in light of the future of medicine and healthcare

Medical and healthcare

→ P39

- Wood-derived pharmaceutical products
- Cell culture substrates for controlled cell orientation
- Medicinal plants

Using technologies cultivated over 150 years to solve various environmental issues

Eco-friendly products

→ P40

- Polylactic acid laminated paper
- Aqueous coated paper cup base
- Biomass plastic films
- Cellulose composites
- Eco-friendly heat shielding film

New Materials Derived from Wood

Creating New Value for Pulp

As paper consumption declines, we will create new value for pulp as a raw material and we will pursue research to extract its potential, develop new materials, and enter new businesses.

Development of Biomanufacturing Technology with Wood Resources as Raw Materials

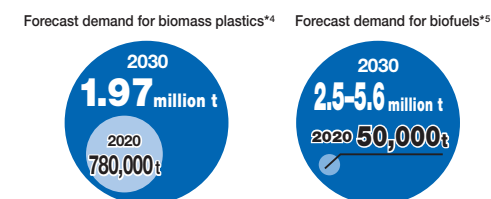
We are making major contributions to biomanufacturing innovation through the development of new materials utilizing our abundance of wood from sustainable forest management.

To contribute to a decarbonized society in which petroleum-derived fuels and plastics are replaced with those derived from biomass, we are pursuing the development of new materials derived from the wood which is obtained from sustainable forest management. Needs are expected to increase for sugar solution, which is a key raw material of various biomanufacturing*¹ and for biomass plastics, such as polylactic acid, and ethanol, which can be used in the manufacture of basic chemicals, SAF*², a focus of the aviation industry's attention, both of which are obtained by combining sugar solution with fermentation.

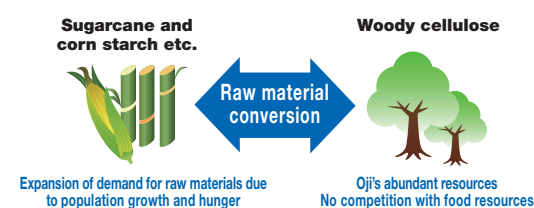
We refined our manufacturing technology for wood-derived ethanol after it was adopted as a NEDO project*³ until 2018. For wood-derived sugar solution as well, we have succeeded in the development of proprietary technologies, including saccharification enzyme recovery, and are now undertaking sample work, which is being evaluated.

*1 Production of plastics, rubber, fibers, fuels, and other products using smart cells (micro-organisms that raise the productivity of beneficial substances), with biomass-derived sugars as raw materials
*2 Sustainable aviation fuel: Fuel seen as the trump card in the decarbonization of the aviation industry
*3 Demonstration Project for Comprehensive Development of Cellulose-based Ethanol Production System (April 2015–March 2018)

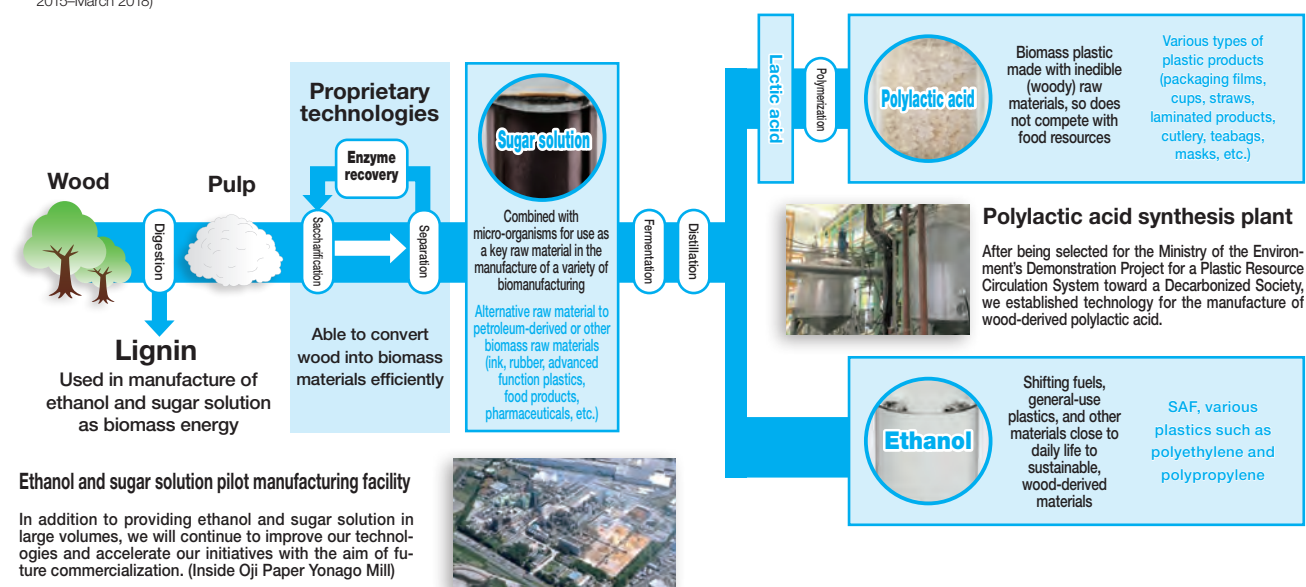
Sudden Expansion of Demand for Biomass Plastics and Biofuels in Japan



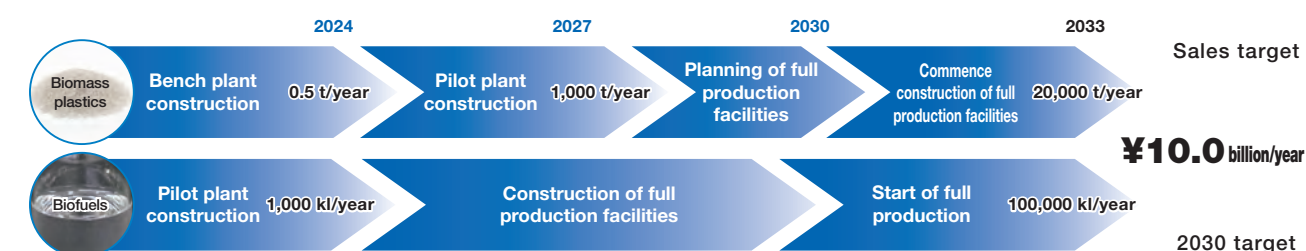
Challenge for the development of new materials derived from wood



*4 From Fourth Fundamental Plan for Establishing a Sound Material-Cycle Society, Ministry of the Environment (2018)
*5 From Government-Private Sector Council for the Promotion of Introduction of Sustainable Aviation Fuel (SAF), Ministry of Economy, Trade and Industry (2022)



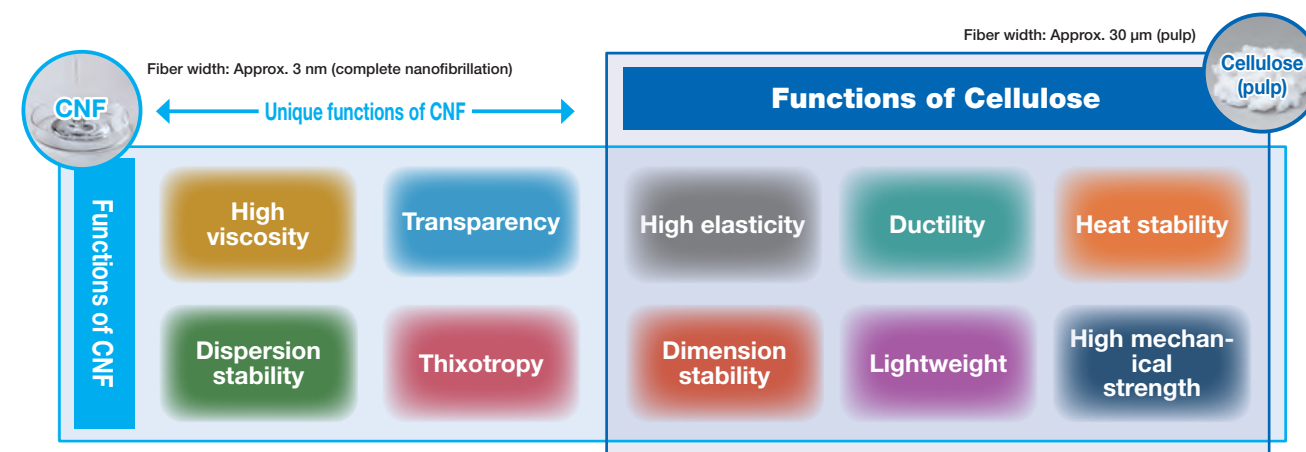
Future Initiatives



Use of Cellulose That Accommodates Social Changes

To accommodate changes in society and customers' requirements, we are promoting development for the effective use of cellulose materials, from CNF to pulp.

In the course of developing applications for CNF, we have learned that, in addition to demand for unique functions that are only obtained by conversion to CNF, there is also demand for the functions that cellulose originally possesses. To meet this demand, as well as expanding applications that make use of CNF's unique functions, we also embarked on the development of applications for pulp, making use of cellulose's original functions. This will enable us to select and propose the cellulose materials that best suit the customers' requirements, allowing us to expand the fields in which these materials are used.



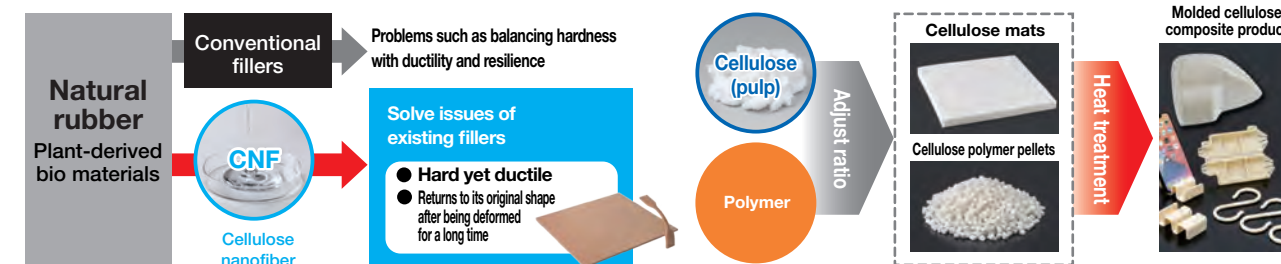
Development for the Expansion of Market for CNF

Exploration of Applications with Expected High Consumption of CNF

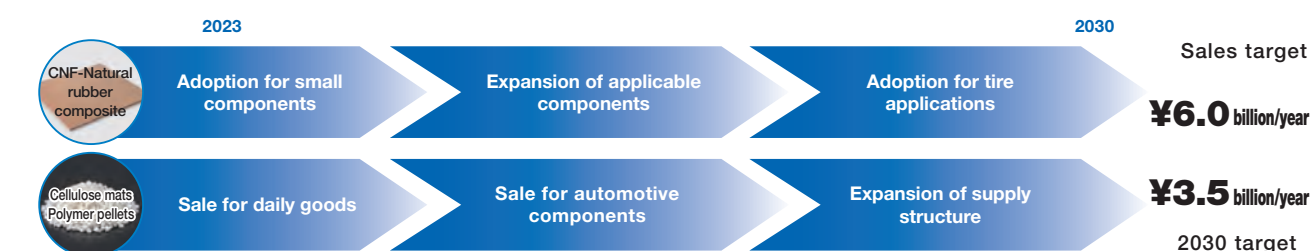
To increase consumption of CNF, we are promoting the development of CNF composite materials that will enable the provision of CNF's unique functions in forms that are easy to handle, and we are exploring the possibility of new applications for such composite materials.

CNF-Natural Rubber Composite

By compounding natural rubber with CNF, we successfully achieved both reinforcement effect (hardness) and stretch, and we discovered potential for a novel rubber material by replacing carbon black, the existing petroleum-derived reinforcing material, with biomass. We will proceed with the development and practical application of this material in anticipation of its future adoption for tire applications, which are expected to yield high CNF consumption.



Future Initiatives



Medical and Healthcare

Challenge to a New Field in Light of the Future of Medicine and Healthcare

As the super-aging society progresses and interest in extending healthy life expectancy grows, there is a need for new and different form of medicine and healthcare. The Oji Group is taking on the challenge of new domains through our efforts to utilize wood resources in the medical and healthcare field.

Drug Discovery from Wood Resources

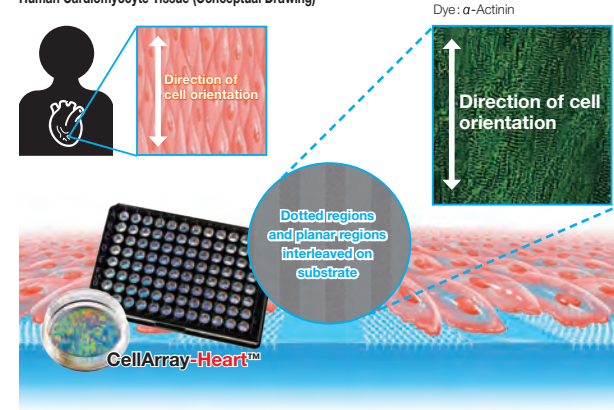
Wood-derived Pharmaceutical Products

The Oji Group aims to contribute to human and animal health through the development of “sulfated hemicellulose.” Sulfated hemicellulose is a compound obtained by “hemicellulose,” one of the major components of wood. It has been confirmed to have anti-inflammatory and anti-coagulant effects. In addition, this compound is similar to heparin, an animal-derived pharmaceutical product used all over the world. By replacing this animal-derived pharmaceutical product with a wood-derived one, it is expected to accommodate a wide range of needs.

We are currently filing a prior application for an arthritis drug for animal use, and we have obtained approval for the manufacture and sale of veterinary drugs. Going forward, we will develop it into a drug for human use and work on the building of the pharmaceutical business, leveraging the compound's property of being derived from wood.



Human Cardiomyocyte Tissue (Conceptual Drawing)



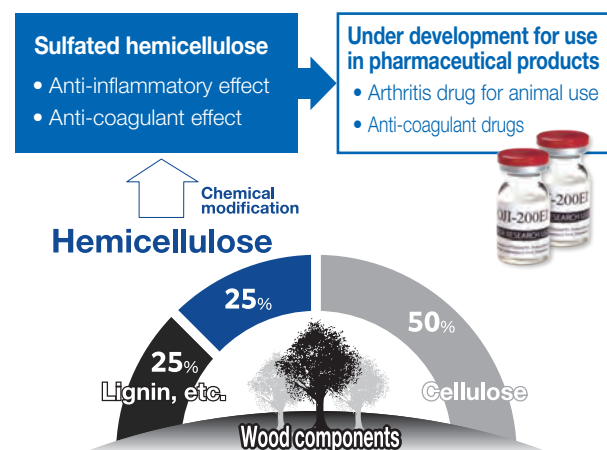
Cultivating cardiomyocytes on this product enables reproduction of cell orientation similar to that in vivo.

Stable Supply of High Quality, Domestically Grown Raw Materials for Chinese Herbal Medicines

Large-scale Cultivation of Medicinal Plants

Medicinal plants are used in a wide range of applications, including pharmaceuticals (primarily Chinese herbal medicines), cosmetics, and food products, making them an indispensable plant resource in daily life. However, in many cases, supply is dependent on wild plants imported from overseas, resulting in risks such as resource depletion, export restrictions, and foreign exchange fluctuations, as well as issues such as environmental conservation and traceability. For these reasons, a shift to domestic production is needed.

Amid such needs, leveraging our forest tree breeding technology, we have successfully established cultivation techniques for licorice, the most used medicinal plant, and we are now working on large-scale cultivation.



Nanostructure Technology for Regenerative Medicine and Drug Discovery

Cell Culture Substrate for Controlled Cell Orientation, CellArray-Heart™

The issue was that the cellular functions of cardiomyocytes generated from human iPS cells were not developing as far as in vivo cells (they were not maturing). Focusing on the fact that cardiomyocytes are “oriented” (facing the same direction) in vivo, we have developed CellArray-Heart™.

This product is a cell culture substrate fabricated by our original technology that has nanodot regions with a pitch of several hundred nm and planar regions interleaved in parallel stripes. When culturing human iPS cardiomyocytes, we can reproduce the same cell orientation as they have in vivo. Because it has been confirmed that iPS cardiomyocytes that have been oriented when cultured progress to maturation, it is hoped that this method will help avoid animal testing in drug discovery and have applications in regenerative medicine.

We are currently proceeding with the collection of detailed data for use in promotional activities with our joint research partner, Juntendo University.



Eco-Friendly Products

Using Technologies Cultivated over 150 Years to Solve Various Environmental Issues

Toward solving environmental issues, such as reduction of CO₂ emissions and plastic consumption, we develop eco-friendly products that meet a wide range of needs by making full use of our abundant fundamental and core technologies cultivated over the years.

Recycling-friendly Paper Products

Laminated Paper Using Plant-derived Polylactic Acid

The incineration of ordinary laminated paper as combustible waste results in the emission of fossil fuel-derived CO₂. Since the plastic layers of the laminated paper we developed use plant-derived polylactic acid, combustion of the paper does not increase CO₂ in the atmosphere. In addition, this paper is biodegradable under compost conditions.



Recyclable Aqueous Coated Cup Base

Traditional paper cups, made of plastic laminated paper, are not suitable for recycling and are generally treated as combustible waste. However, by leveraging our technology to apply special aqueous resin to the cup base in a thin and even manner, we successfully developed a paper cup base that still has the functions required for paper cups, while being recyclable as paper material.



Biodegradable Plastic-Cellulose Composites to Reduce Environmental Burdens

Cellulose Composite, Resoil-Green

We have developed resin materials that are composites of biodegradable plastics and wood-derived cellulose (pulp). The use of pulp means that this product can achieve a high degree of biomass as well as a high biodegradation rate. In addition, the product improves various properties of resin such as strength and stiffness. Since all raw materials of the products are biodegradable in soil, compared with regular plastics, the products can contribute to reducing environmental burdens.



Emission Reductions of CO₂ from Fossil Fuels by the Development of Biomass Plastic Films

Biomass plastic film, Alphan G

We have developed a polypropylene film containing polylactic acid, which as the plant-based plastic has a low environmental impact to reduce CO₂ emissions from fossil fuels. This product, Alphan G, was certified as a Biomass mark product* and has been commercialized.

We are also working on the development of heat-sealing films and will continue to develop a wide variety of products that contribute to SDGs.

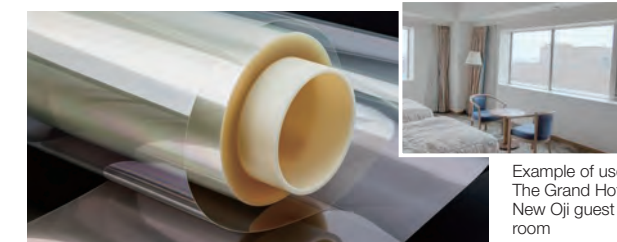
* Biomass mark certified by the Japan Organics Recycling Association



Contribution to Energy Conservation through Development of Heat Shielding Film

Anti-heat Windshield Film

To mitigate soaring utilities costs and reduce the environmental burden of increased use of electric power, heat shielding materials that can be adhered to windows in automobiles and buildings are attracting attention. Our heat shielding film offers both high heat shielding performance and transparency, and in December 2022, we added a new product that uses recycled materials for release films to our line-up. It is currently available as film for automotive windshields, and we are considering expanding its application to building windows.



Example of use:
The Grand Hotel
New Oji guest
room

New Value Creation through Green Innovation

Initiatives for New Business Development

We will create business models and businesses that will open up a circular future.

General Manager,
Corporate Business Development Division

Teruyuki Mori



As part of our structural reforms towards achieving the "long-term vision" goals, we established the Corporate Business Development Division in October 2022 with the aim of developing businesses that will contribute to building of a sustainable society and growing those businesses into future earnings pillars.

We will aim to expand our business by establishing the comprehensive management and promotion system for new business, such as the liquid packaging carton business, one of our environmental response businesses, the effective utilization of company owned forests (P32: Oji Forest Value-Creation & Promotion Department), and eco-friendly paper products that will contribute to de-plasticization.

Liquid Packaging Carton Business

In September 2020, the Oji Group established Ishizuka-Oji Paper Packaging Co., Ltd. in a joint venture with ISHIZUKA GLASS Co., Ltd. and entered the liquid packaging carton business.

For chilled cartons for refrigerated storage, such as milk and juice, we have already achieved an integrated structure in Japan covering the entire process from manufacturing base paper to converting and sales. In the Liquid Packaging Carton Department that launched in October 2022, we are actively working to enhance a structure and promote sales activities to drive forward and expand the business

Acquisition of IPI (Italy) for the Expansion of Business into Overseas Markets

As part of our overseas strategy for the liquid packaging carton business, we acquired IPI S.r.l. (Italy), a manufacturer and distributor of converted paper and filling machines for aseptic packaging cartons, in May 2023. This acquisition aims to enter the aseptic carton market, which is the largest segment in the global liquid paper carton industry.

This will enable integrated production of base paper and converted paper similar to our chilled cartons, allowing the Oji Group to make a full-scale entry into the Asia and Oceania markets, where the Oji Group has particular strengths. In addition, by leveraging IPI's sales network in newly emerging countries like Africa and other regions, the Oji Group anticipates the entry and expansion of other businesses.

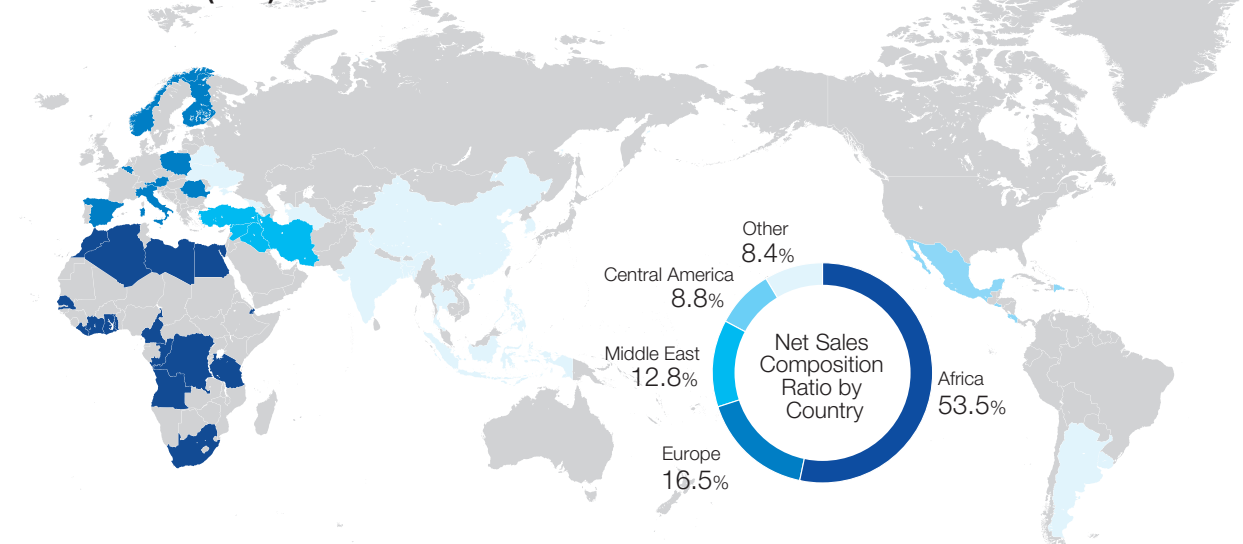


Chilled cartons



Aseptic packaging cartons
* Cartons are sterilized in filling machine that keep contents for six months to a year at room temperature.

IPI's Sales Area (2022)



Business Promotion for Eco-Friendly Paper Packaging

Oji Group is promoting the development and commercialization of a variety of paper packaging products and the establishment of new business models as an activity toward solving environmental issues, such as reduction of CO₂ emissions and plastic consumption.

Commercialization of Eco-Friendly Paper Packaging to Meet a Wide Variety of Needs

■ FlatSkin®: Cardboard That Enables Prolonged Shelf Life and Attractive Presentation of Fresh Foods

This is a package comprising cardboard and film that can be separated for disposal. The vacuum packaging of meat and fish suppresses drips, and printing on the cardboard offers attractive presentation of foods.



■ Paper-made Blister Pack: a Packaging That Offers Effective Presentation of Contents

This is composed of three pieces; paperboard top, tray, and divider. Even without using plastic films, it is able to secure and protect the products inside. Because the package can be printed on and window holes can be made, this product offers more effective presentation of the contents such as daily goods.



■ Flanged Paper Tray: Microwave-safe Packaging

This is a packaging that can be top-sealed and that has a flanged structure for ease of carrying and four-cornered adhesion construction that provides superior container strength.

These containers are microwave-safe and can also be used as tableware.



■ Tapered Paper Tray: Food Tray with Separable Cardboard and Film

This is a paperboard-based tray with a resin film that covers the surface. It is designed so that the cardboard and film can be easily peeled away, making it easy to separate for disposal after use. Because the flange is flat, there is no concern about the contents leaking after top-sealing.



Building of New Recycling System

■ Recycling System for Paper Cups

Conventional paper cups, made of plastic laminated paper, are not suitable for the existing recycling systems, so are generally treated as combustible waste. Leveraging our recycling technologies that we have cultivated over many years, Oji Group has built a system that enables recycling of paper cups by incorporating paper cup crushing technology and washing technology. The collected paper cups are reborn into other familiar paper products (corrugated containers, tissues, etc.)

We will also make an effort in the recycling of the paper cups used by our customers.

Topics Reduction of CO₂ Emissions by Introduction of Paper Packaging

The calculation*1 and comparison of the life-cycle CO₂ emissions of petroleum-based plastic packaging and sustainable paper packaging shows that paper packaging emits less CO₂ than plastic packaging*2. Therefore, the introduction of paper packaging can contribute to CO₂ emission reduction. For more details, please see our website.

*1 CO₂ emissions are calculated by converting greenhouse gas (GHG) emissions such as carbon dioxide (CO₂), methane (CH₄), and dinitrogen monoxide (N₂O) into CO₂. The calculation is made based on LCA (Life Cycle Assessment) methodology.

*2 Calculation results of reduction rate will vary, depending on packaging material and layer structure. (It is assumed that the paper packaging material is MG bleached kraft paper 70 g/m² and that the method of printing is gravure printing.)

Sustainable packaging | CO₂ reduction effect

➔ <https://solution.ojiholdings.co.jp/ojipaperpackage/sustainability/> (available in Japanese only)

