

## Research & Development



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### Creation of Innovative Value

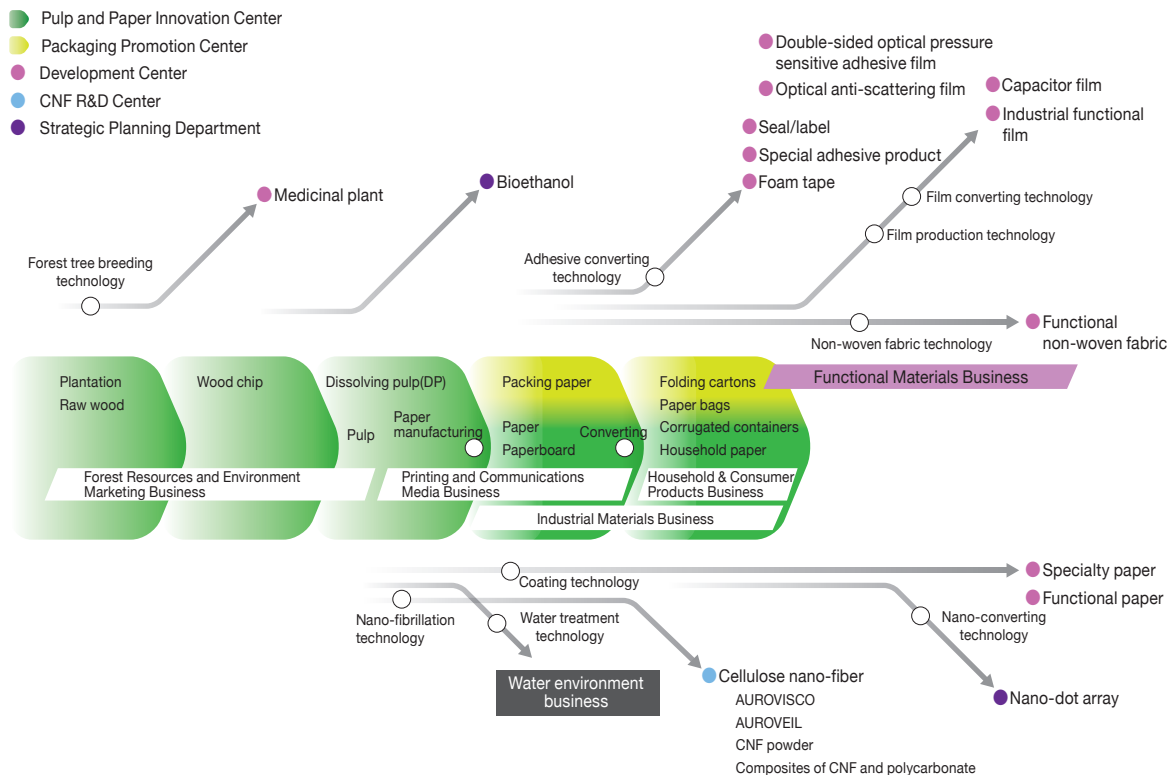
With the aim of creating new business and strengthening the competitiveness of current businesses in mind, the Innovation Promotion Division propels Oji Group's business restructuring through developing the seeds of technological innovation, as well as cultivating new markets and developing new products by questing new needs.

#### Priority Strategies of the Innovation Promotion Division

- Acquire new needs, establish business models, propose and implement new seeds, and create a value chain
- Contribute to sales/profits through creation of new businesses
- Strengthen cost competitiveness through refinement of pulp and paper technologies

### Value Creation by the Innovation Promotion Division

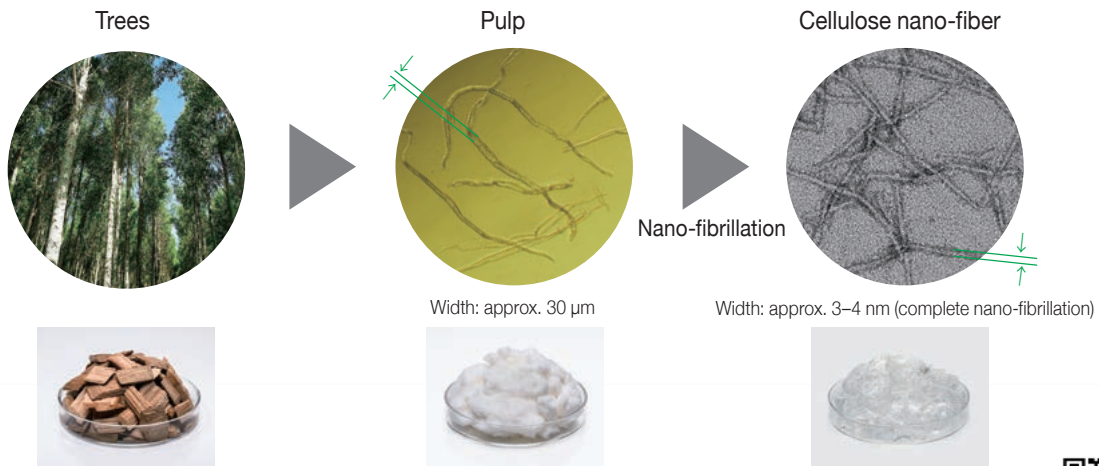
Each research center promotes development of highly functional and high value-added products by evolving underlying core technologies cultivated from paper manufacturing and film converting. We also undertake development of new business utilizing our technologies such as tree breeding and water treatment. In FY2018, Packaging Promotion Center was established to reinforce the total packaging business from paperboard and packing paper to corrugated containers, folding cartons, and paper bags. The Strategic Planning Department takes the lead in formulation of medium-term strategies for the Innovation Promotion Division, creation of new businesses, cultivation of new seeds, and formation of value chains.



## ▶ Cellulose Nano-fiber

Cellulose nano-fiber (“CNF”) is a plant fiber (pulp) that is finely fibrillated to nano-order level, 1/1,000,000 of 1 mm, where its width is equivalent to 1/20,000 of a hair.

Oji Group has developed a groundbreaking process for its CNF production by utilizing a chemical treatment “Phosphate Esterification,” which is potentially the most feasible for commercialization, requiring a relatively small amount of energy for fibrillation.



## ▶ Initiatives for Commercialization of CNF

For details on the CNF business

In addition to operating manufacturing demonstration facility of “CNF slurry\*” at Oji Paper Tomioka Mill using a proprietary phosphate esterification method, we installed the world’s first manufacturing demonstration facility of our unique “continuous transparent CNF sheet” in January 2018. “AUROVISCO,” CNF slurry, has been officially adopted as a thickener for car chemicals. In addition, adoption of “AUROVEIL,” developed for cosmetics applications, is also under consideration.

We have also developed “AUROVEIL,” continuous transparent CNF sheet, “CNF Wet Powder” with CNF slurry concentration of 20% or more, “CNF hydrophobic power” that can be dispersed in organic solvents, and composites of CNF and polycarbonate resin, and other materials; and accelerated the development of applications in a wider range of fields.

\*Viscous CNF that can be dispersed in water

### AWARDS

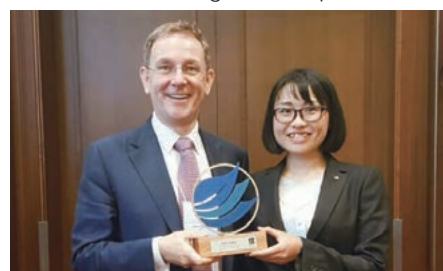
#### in-cosmetics Global 2018

“AUROVISCO CS,” which we developed jointly with Nikko Chemicals Co., Ltd., won the silver prize in the Functional Ingredients category of the Innovation Zone Best Ingredient Awards 2018 at in-cosmetics Global, the world’s largest exhibition of cosmetics-related ingredients.



#### ICFPA\* Young Researchers Award

An Oji Group researcher was selected for an excellence award as a young researcher responsible for research and development of next-generation forestry technologies and innovative technologies in the forest and paper industry. The researcher gave a presentation on her research at a conference with CEOs from forest and paper industry firms in various countries attending and was presented the award.



\*International Council of Forest & Paper Associations



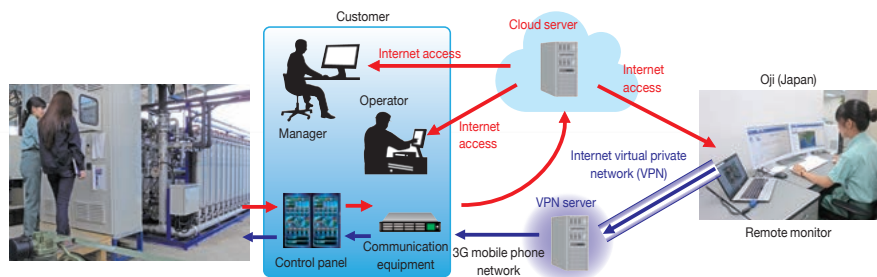
## ▶ Establishment of Water Treatment Technologies

In the area of water treatment technologies, we are leveraging the water production and water treatment expertise that we have accumulated over many years through our papermaking technologies and combining them with various needs to offer water treatment systems suitable for all water environments. Based on appropriate on-site investigations, water quality analyses, and laboratory experiment technologies and structures, we have introduced proprietary water treatment systems such as a system for removing cadmium from industrial waste water and industrial water production facilities at an industrial estate in Thailand. Going forward, we will seek to expand the adoption of these systems as we promote innovation in water treatment system technologies, contributing to the development of water environments not only in Japan, but also in Southeast Asia and other overseas regions.

Business conductor: Oji Engineering

Technology developer: Water Environment Business Promotion Section, Innovation Promotion Division

### IoT-based remote support service introduced at industrial water production facility in Thailand



Oji Group installed an industrial water production facility at an industrial estate in Thailand using proprietary chemical treatment with OJI-MEMBRANE ultrafiltration membrane. We also provide a service that supports optimal operation of the facility through the use of IoT-based remote monitoring. This service prevents problems before they occur to ensure stable production of high-quality industrial water.

### Proposals for water treatment chemicals



OJI-FLOCK  
(flocculants)



OJI-ION  
(ion exchange resin)



OJI-CARBON  
(activated carbon)

We use our accumulated expertise to propose appropriate water treatment chemicals that can ensure stable operation of equipment even when water quality varies depending on the external environment or operations.

#### Products offered

- Flocculants for waste water treatment
- Ion exchange resin for production of pure water
- Activated carbon for deodorization and organic matter treatment
- Chemicals for boiler feed water



## ▶ Medicinal Plants Cultivation Technologies

Oji Group develops cultivation technologies of highly anticipated medicinal plants. Licorice is the most commonly used medicinal plant, found in some 70% of Kampo medicines. At present, most raw materials are dependent on imports of wild licorice from overseas, but there are calls for domestic production in order to respond to fear of resource depletion accompanying demand increase and export restrictions. We have established Japan's first cultivation technology that shortens the time required from seed sowing to harvesting of licorice from five to six years to just two years, while conforming to Japanese Pharmacopoeia's active ingredient standards of containing at least 2.0% glycyrrhizin in cultivated licorice. We have started a large-scale cultivation trial in the Nayoro area of Hokkaido in 2017.



A large-scale licorice cultivation trial

\* Licorice root harvested 18 months (1.5 years) after seeding. The roots are used in oriental medicines.



## ▶ Development of Environmentally-conscious Products

The European Union (EU) recently proposed a law prohibiting the use of disposable plastic products in order to protect marine organisms, and many major restaurant chains in the United States plan to review their use of plastic containers and straws. As a result, demand for plastic replacements is rising globally. While we have manufactured various types of base paper for food containers such as those for beverages and yogurt, etc. as well as containers and packaging paper used in fast food restaurants, the Packaging Promotion Center will play a central role in developing biodegradable plastics which can take the place of conventional plastics and also paper products with new functions, in the future.

### 1. Development of composites of biodegradable plastic and pulp

Oji F-Text is developing plastic pellets made from a combination of pulp with polylactic acid\*, a biodegradable plastic. By combining plastic with pulp, the rigidity of molded products increases, heat resistance (temperature of thermal deformation) improves, and time required for injection molding can be reduced, leading to expectations for expanded application in molded products.

\* Polylactic acid is a plant-derived synthetic resin that can be recycled by composting.



Plastic pellets  
(Left: Polylactic acid only; right: polylactic acid combined with pulp)



Examples of molded items  
(Top: Polylactic acid only; bottom: polylactic acid combined with pulp)

### 2. Development of packaging material with barrier properties

We developed a recyclable packaging material in order to replace packaging materials that have barrier properties and are made primarily from plastic with paper. The developed product is a multi-barrier paper that acts as a barrier against water vapor and oxygen. Compared to paper alone, the product provides barrier properties equivalent to those of general barrier film.



Packaging materials with barrier properties

### 3. Development of paper cup products (traveler lids) and sample distribution of paper straw base paper

Plastic lids for paper cups are the norm, so we developed a biodegradable paper lid made from recyclable pulp. This product has excellent water and thermal resistance and can be used to cover paper cups for both hot and cold products.

Oji F-Text has started providing samples of paper straw base paper suitable for manufacturing paper straws with functional water resistance produced by spiral processing.



Paper cup lid (traveler lid)