# Research and Development

## Based on our core expertise of adhesion and coating technologies, we will continue to create various functional products.

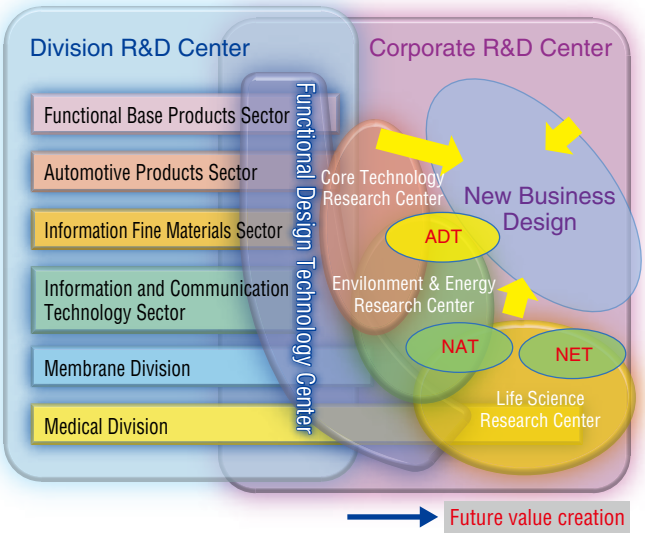
### Research and Development Strategy

Our Business Division R&D Center and Corporate R&D Center work together as one to perform research and development activities with the goal of growing existing business fields and creating future value.

The mission of our Business Division R&D Center is to quickly create products and services that offer new functions to satisfy our customers, while our Corporate R&D Center works to create value that can be offered to all types of customers. In addition, in order for us to continue as a viable business, it is essential to create major new projects.

Aiming for project-creating R&D, we continuously work to build basic technologies by performing groundbreaking innovative technological development.

**Research and Development System**

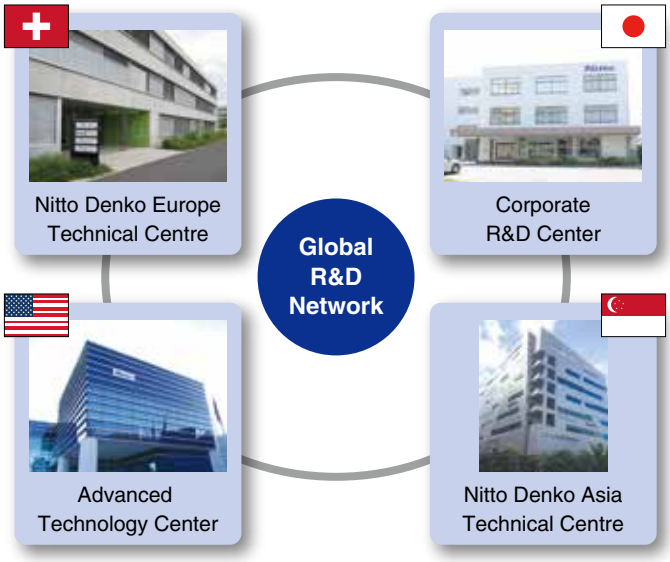



ADT : Advanced Technology Center, USA
NAT : Nitto Denko Asia Technical Centre, Singapore
NET : Nitto Denko Europe Technical Centre, Switzerland

### Global R&D Network

The Nitto Group's global R&D system comprises four bases, located in Japan, U.S.A., Europe (Switzerland) and Asia (Singapore), and promotes locally-headed R&D activities taking advantage of each area's special features. We aim to create unique technologies and the seeds of new business by combining a wide range of knowledge, technologies and methods, to generate a chain of new value.

In October 2013, we established Nitto Innovations, Inc. in Silicon Valley, U.S.A. In line with a search for new technologies and projects around the area, we aim to commence new business in union with venture companies, as part of our strategy of the "creation of ample business opportunities."

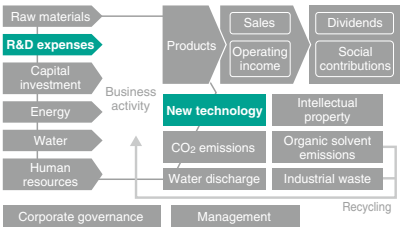



### RAYCREA® - Encapsulating Sheets - improving the electricity generation performance of solar panels

Considering $CO_2$ emissions and the reduction of dependence on single energy sources (energy mix), photovoltaic electricity generation has recently become very popular, and various research and development to improve the performance of it is being carried out.

Encapsulating sheets are inserted into a solar panel between the surface glass and backing on the reverse side to fix the PV cells in place. Encapsulating sheets need to allow sunlight to efficiently penetrate the PV cells while still protecting both the PV cells and materials contained in the solar panels. In addition, as they are exposed to the elements for more than 20 years, high endurance and reliability are also required.

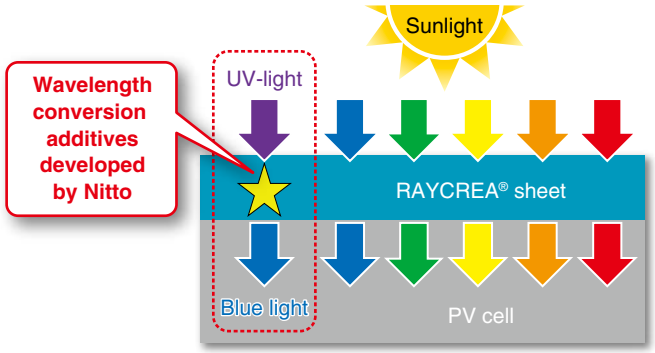
Nitto has succeeded in developing RAYCREA® - Encapsulating Sheets, that are highly reliable and improve electricity generating performance. The encapsulating sheets have wavelength conversion additives which Nitto has uniquely developed. The sheets absorb close to 100%



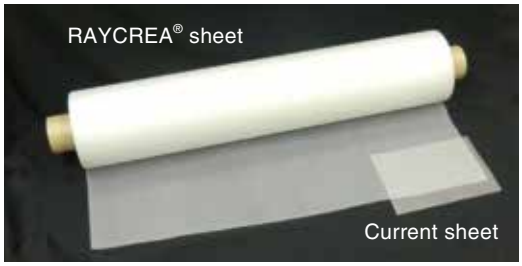

of the UV-light contained in sunlight and produce blue light. UV-light is generally considered to be harmful to solar panels, so it is typically cut by ultraviolet absorbers. However, it has been verified that converting UV-light into visible-light enables the more effective use of energy and increases electricity generation by approximately 2 % compared to conventional sheets. When applied to 200-watt solar panels, the electricity produced increases by approximately 4 watts. When stable operation is maintained for a long period of time, an appreciable effect can be anticipated. RAYCREA® sheets are used in the same way as conventional sheets and are easily fitted to existing solar panel manufacturing equipment.

At present, we are dedicated to marketing RAYCREA® in 2015.

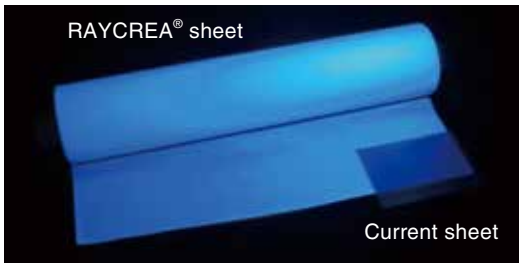
**Diagrammatic illustration of cross-section of solar panel fitted with RAYCREA® - Encapsulating Sheets**

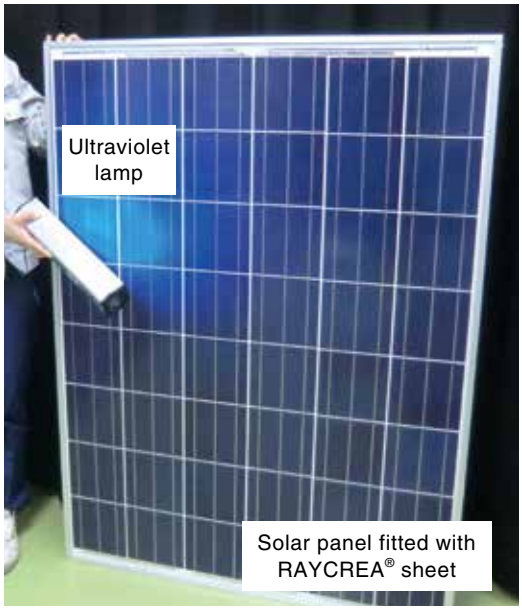



"Cutting harmful UV-light"
+
"Improving electricity output by converting wavelength"




UV-light




## Development of Gecko Tape Using Carbon Nanotubes

**Expansion of Gecko Adhesion Technology to Fixing Material for Analysis Measurement**

The Gecko Tape which Nitto developed jointly with Professor Yoshikazu Nakayama of Osaka University evolved from biomimicry technology, applying technologies inspired by the natural world.

The gecko is able to walk across a wall, because fine hairs which grow abundantly on its toepads establish close contact with the surface of the wall or ceiling, even if it is uneven. Contact can then be easily broken by altering the angle between the hair and the wall surface. We have reproduced this gecko hair artificially using carbon nanotubes (CNT) to create a tape to provide strong adhesion and easy de-adhesion.

Focusing attention on the material properties of carbon nanotubes, we promote the use of Gecko Tape in analysis. The use of Gecko Tape as an attaching material minimizes contamination and enables analysis in high or low temperature environments, something which is difficult with conventional conductive tapes and pastes, realizing unprecedentedly accurate analysis data.

### Advantages of Gecko Tape

1) No temperature restrictions: Analysis in high and low temperature environments (a wider range of temperatures acceptable for analysis) is possible.

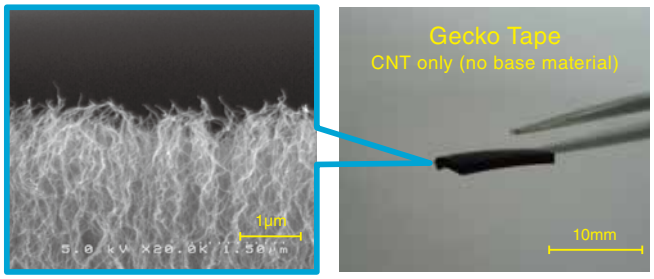
2) No displacement (anti-drift): Accurate data that is free from the effects of adhesives is obtainable.

3) No contamination: Accurate data that is free from the effects of outgassing is obtainable since no solvents are used.

4) No static buildup: The conductivity of CNT inhibits static buildup, preventing any degradation of analysis images.

For details, please visit the following website:
http://www.nitto.com/jp/en/products/group/semicon/yamori/

Toepads of a gecko



Gecko Tape made of carbon nanotubes

## Development of Anti-fibrosis Drug with Molecular Targeting DDS Technology Platform
Clinical studies ongoing

In June 2013, Nitto initiated clinical studies of a drug for treating liver and other organ fibrosis in the US.

Liver cirrhosis, which is one of the organ fibrotic diseases, is known to be intractable, with 6 million current sufferers throughout the world. Fibrosis is caused by deposition of excess amounts of collagen, which is produced by stellate cells. In the case of liver cirrhosis, when the liver is chronically inflamed, collagen secreted by hepatic stellate cells is deposited in the liver in excess and consequently, function of the liver is impaired.

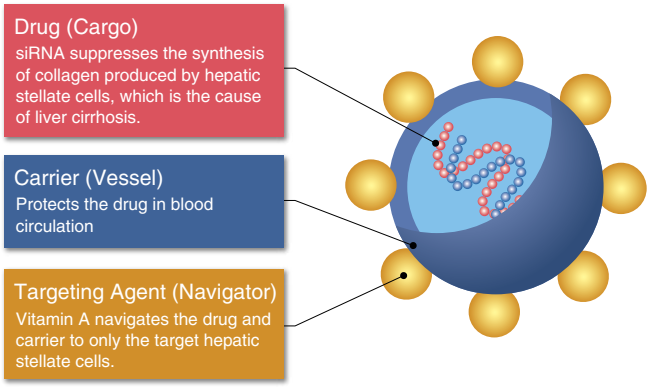
Nitto has developed a revolutionary and safe drug which leads to resolution of fibrosis by combining the discovery of a method for targeted delivery to hepatic stellate cells by Professor Yoshiro Niitsu of Sapporo Medical University and Nitto's DDS technologies, with the technical collaboration of Hokkaido University. In order to suppress collagen synthesis, we employed siRNA (oligonucleotide) as a drug component, then designed a unique drug formulation. The siRNA (drug) is encapsulated in a special drug carrier (vessel) with vitamin A moiety (navigator), which is known to be taken up specifically by stellate cells.

Basic patents covering this new drug have been granted in Japan, the US, Europe, China, Australia and Korea. In addition, patent of the drug composition was also granted in the US in 2014.

The clinical study phase-1a was completed in normal healthy volunteers in the US, providing conclusive evidence of tolerance even at high doses. We are now ready to enter the next stage.

This drug will be applicable to not only liver cirrhosis but also other organ fibrosis and cancer. We will continue to conduct research activities to develop other new drugs.

**An overview of the new drug**
**<The vessel and navigator deliver the drug.>**



The carrier (vessel) delivers the siRNA drug (cargo) exclusively to the hepatic stellate cells by means of the vitamin A targeting agent (navigator).