Research and Development Trends

Development of New Materials Using the SPring-8 Large-Scale Synchrotron Radiation Facility

Dedicated beamline for industry-academia consortium completed

1. Overview

The Advanced Softmaterial Beamline Consortium was formed on 15 February 2008 by 19 enterprise groups, including our own, in order to construct a contract beamline using the advanced light sources available at the SPring-8 Large-Scale Synchrotron Radiation Facility* for the development of new cutting-edge materials.

An aerial view of the SPring-8 large-scale synchrotron radiation facility
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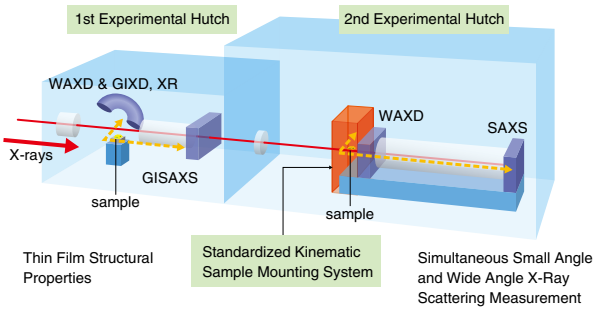
The BL03XU contract beamline, which is the first of its kind at SPring-8, was completed on 4 February 2010. The advanced light sources made available by the government at this large-scale synchrotron radiation facility have made it possible for academics to use their knowledge and for private sector researchers to use their skills in the quest for new polymer materials, with the hope that further advances in polymer science will be made.

It is hoped that the use of synchrotron radiation as a tool will lead to the development of new innovative applications for polymer materials.

2. Contract Beamline Overview



An overview of the Advanced Softmaterial Beamline

Through using the contract beamline constructed by the consortium, it is possible to carry out X-ray analysis and the scattering measurement of polymer materials on a nano-submicron level simultaneously. By using a special brightness enhancement light source device it is possible to achieve high resolution and the formation of micro-beams. The contract beamline consists of Hutch 1 (thin film structural properties) and Hutch 2 (dynamic nano-meso scale structural properties).

The aim of the first experimental hutch is to evaluate the dynamic structural properties of organic and polymer thin film surfaces and interfaces. This involves examining the degree of crystallization, crystalline deformation and the long-term structural nature of crystalline polymer thin films in order to ascertain the microphase separated structure of block copolymer thin films and the molecular aggregation of supramolecular aggregates in the thin film state under various environmental

* SPring-8 was constructed in Hyogo Prefecture's Harima Science Park City by the Institute of Physical and Chemical Research (Riken). It is a third generation large-scale synchrotron radiation facility capable of producing the highest quality available synchrotron radiation in the world. Synchrotron radiation is a thin, strong electromagnetic wave emitted from electrons that have been accelerated to almost the speed of light which have had their paths bent by a magnetic field. The name SPring-8 is derived from the description of the facility, which is a Super Photon ring 8 GeV (8 giga electron-volts) facility.

conditions. This system is useful in controlling the structure of polymer materials used in the surface and interfacial regions of polymer thin films. It is expected to significantly contribute to the development of high performance soft matter for use in a wide range of fields, including electronic devices (organic EL, organic FETs and organic memory materials), adhesion, coating, printing and biomaterials.

The aim of the second experimental hutch is to discover the correlation between the dynamic structure of polymer materials and their physical properties in order to develop novel materials. With this setup it is possible to carry out measurements to clarify the formation and deterioration mechanisms of polymer materials resulting from changes in external conditions, such as stress associated with stretching and spinning, heating and cooling, pressure and solvent evaporation. It is also possible to evaluate the structural properties of polymer materials on a microscopic level, the electron density distribution of polymer crystals, the deformation mechanism of molded polymer products and the structural properties of polymer materials in processes such as molding and processing. Furthermore, the area where the second hutch is located is large enough to allow for the use of a standardized kinematic sample mounting system. This system makes it possible for enterprise groups to bring in their own large-scale devices, such as manufacturing lines, making it possible for them to take full advantage of the features of the contract beamline.

3. Future Developments and the Ripple Effect

By utilizing this contract beamline it is our aim to develop and use new analysis and evaluation technologies to examine the surface and internal structure of materials that would be impossible to evaluate using other methods.

It is our hope that we will be able to make a significant contribution to the economic growth by producing an innovative new framework based on polymer materials that can be used to develop the next generation of cutting-edge materials.

Nitto Denko Support for National Research and Development Projects

We are dedicated to using our technology to participate in national research and development projects that are in line with the future national strategy.

1. CO_2 Recovery Technology

(This government-subsidized research is being carried out by Nippon Steel Engineering Co. Ltd. in conjunction with the Ministry of Economy, Trade and Industry.)

In this project we are developing membrane modules for concentrating CO_2 gas emitted by sources such as power stations in conjunction with the Research Institute of Innovative Technology for the Earth (RITE) and four private companies. In fiscal 2009 we carried out test operations using one of our prototype membrane modules with gas generated by a new type of power plant. It is hoped that membrane modules will prove to be highly energy efficient and it is our intention to continue to develop them in the future.

Test Plant (ECOPRO: JCOAL project sponsored by the Ministry of Economy, Trade and Industry.)

2. Bioethanol Concentration Technology

(NEDO: New Energy and Industrial Technology Development Organization)

In recent years, bioethanol has been in the limelight as a fuel additive for automobiles. Recently, research

and development is being actively carried out regarding ethanol made using cellulose from materials such as wood and rice straw. Such materials do not compete with the supply of food. As a participant in the NEDO project, Nitto Denko is carrying out research and development into achieving concentrations of higher than 99.5% using our proprietary membrane modules on 3-5% ethanol which has been manufactured from cellulose.

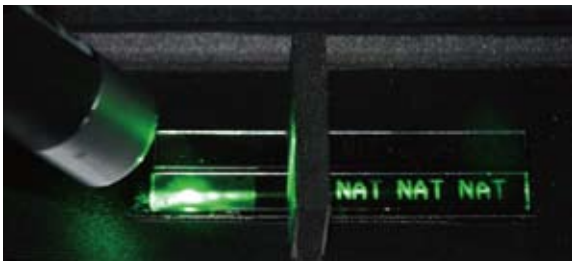
Nitto Denko Asia Technical Centre Combines Optoelectronics with Medical Technologies

The Nitto Denko Asia Technical Centre (NAT) was opened at Fusionopolis, Singapore's latest techno-park, in November 2008 with two major missions; one being to develop new products using the company's proprietary materials for use in environmental and medical applications, and the other to establish long-term partnerships with Singapore-based research and development organizations.

NAT currently consists of 18 young scientists and technicians from seven Asian countries of which more than half of them hold doctoral degree. This brings a unique mix of cultures and perspectives to the work being undertaken at NAT. NAT has submitted 20 patent applications over the past 15 months.

Great progress has been made over the last year in the technological development of NAT's organic optoelectronic sensor device for biomedical applications. It has come about through a combination of Nitto Denko's original and unique polymer technology and Singapore's outstanding R&D infrastructure.

A typical optoelectronic sensor
The biometric information can be obtained instantly by inserting a sample into a small portable device.



An optical waveguide
Light, which enters from the left hand side, passes through the waveguide. The waveguide is a light path formed by precision polymer processing and is located at the bottom of the center wall. The letters, formed by the waveguide, appear on the right hand side.

Biometric information can be obtained instantly through the use of sensor devices which can help with the early detection and prevention of diseases. Furthermore, through using electronic communications alongside "telemedicine", more efficient disease management should be possible. With the potential increase in demand for medical services along with an ever increasing aging population it is hoped that new medical services will make up for a lack of medical staff and hospital beds.

In order to bring products using our proprietary organic optoelectronic sensors onto the market, it is important to find avenues of being able to mass produce sensor devices which are highly sensitive and accurate yet at low cost. Nitto Denko's polymer technology provides a much greater degree of flexibility in the design of integrated organic optoelectronic devices and a lower cost of organic optical waveguide production.

In fiscal 2010, we will make further efforts to perfect these products and to develop new applications.

NAT personnel come from diverse cultural backgrounds.