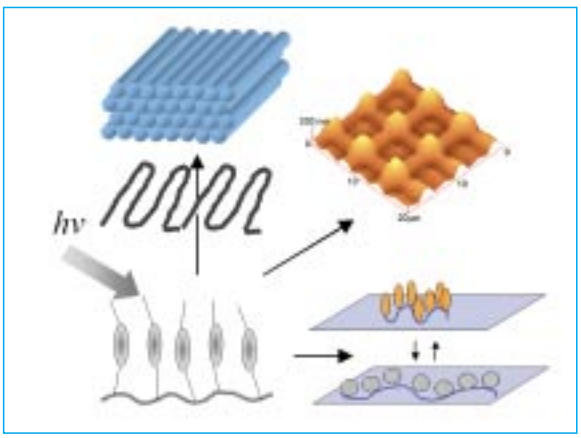
Worldwide R&D

Laboratory Profile: Development of a Photoinduced Molecule System

Seki Laboratory, Graduate School of Engineering, Nagoya University

Seki Laboratory was established in July 2002 by Professor Takahiro Seki, formerly of the Chemical Resources Laboratory at the Tokyo Institute of Technology. Assistant Professor Shusaku Nagano joined our laboratory in November 2002. Our laboratory has now been conducting research for a year after the enrollment of students in April 2003. Associate Professor Yukikazu Takeoka joined us in April 2004, and we are now pursuing our research interests with a total of 25 members: three supervisors, a secretary, a JSPS Postdoctoral Fellow, five PhD students, ten masters course students and five undergraduate students.

Our principal topic of research involves developing assembly methods for new soft materials having photoresponsive functions, such as organic polymer films, liquid crystals, colloidal materials, and compounds thereof, and controlling dynamic functions of these materials. Professor Seki has been particularly interested in conducting research on monomolecular film with nanometer thickness in order to verify that the film provides useful photoresponsive properties. Azobenzene molecules reversibly change molecular shape and other properties in response to light. Professor Seki has incorporated these molecules in high polymers to construct molecular systems in which photoresponsive information at the molecular-level can be effectively conveyed to and amplified at the material level. While much research has been conducted on the manipulation of electrons, holes and optical information using light, our research is distinguished by our efforts to realize dynamic functions in molecules or the material itself that exhibit photoinduced motion, such as expansion and contraction , migration, or molecular alignment. We discovered a photoresponsive monomolecular film that exhibits the world's largest level of expansion and contraction, as well as the most sensitive photoinduced mass transfer. In addition, we succeeded in developing a new technique using light to align polymer films and mesoporous inorganic material. The diagram shows the concept of our research. Our focus is not on the behavior of a single molecule, but on the strong molecular cooperativity (interaction) exhibited when an aggregation of molecules and high polymers behave as a group. The concept of driving molecular systems with light can easily be applied to micromachine technology.



Assistant Professor Nagano has been studying a new approach using the Langmuir-Blodgett (LB) method to form a nanofilm on the surface of water. He developed a technique to create a monomolecular film on the water surface with completely hydrophobic polymers by hybridizing polar liquid crystal molecules. Since LB thin films normally require a polar group in the polymer for fabrication, usable materials are limited. With the technique developed by Nagano, however, LB thin films can be fabricated from many hydrophobic (non-polar) polymers. Accordingly, his technique has attracted a lot of attention as a potential new method for fabricating nano-materials. Nagano has also focused on block copolymers and using light to control their two-dimensional nano-scale phase separation.

Associate Professor Takeoka, who transferred from the School of Engineering at Yokohama National University in April, specialized in providing functions to polymer gels. He prepares a hydrogel material using crystals composed of molecules having uniform particle size as a genetic template. The hydrogel selectively reflects incident rays to emit various colors based on its periodic structure. The wavelength of reflected light varies because the hydrogel expands and shrinks in response to such stimuli as temperature, pH, light, and enzyme activity , causing changes to the periodic structure distance. Accordingly, the hydrogel can be used as a sensor for reflecting various responses to the environment. There is also much interest in employing this gel for directly observing cooperative movement of polymer chains.

Our laboratory has been actively working with other research groups in the field of soft materials, focusing on liquid crystals, gels, and nanofilms. We are committed to continuing studies aimed at developing a system to drive photoresponsive molecules that will be directly useful in practical applications.

Seki Laboratory Website:
http://www.apchem.nagoya-u.ac.jp/butsu3/sekilabo/index.html

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Keiichi Aoyagi, Executive Director, Micromachine Center (MMC)
MBR99 Bldg., 6F., 67 Kanda Sakumagashi, Chiyoda-ku, Tokyo 101-0026, Japan
Tel : +81-3-5835-1870, Fax : +81-3-5835-1873
Internet Home Page http://www.mmc.or.jp/
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