Biography: Hideyuki Nakano was born in Japan in 1963. He graduated from Osaka University in 1985 and obtained M. Eng. in 1988 and Ph.D. in 1991 at Osaka University. The subject of his Ph.D. thesis was "Syntheses, Structures, and Properties of New Multi-Chalcogen TTF Derivatives, Their Charge-Transfer Complexes and Ion-Radical Salts". He joined a faculty member as a research associate at Department of Applied Chemistry, Faculty of Engineering, Osaka University in April, 1991 and was prompted to an associate professor in 2000. In 2010, he moved to the present position Muroran Institute of Technology as a full professor. His recent research interests are photochromic materials exhibiting photomechanical behaviors, fluorescent materials in response to external stimuli, and hybrid materials with smart photo-functions.

Representative publications.


Photomechanical Behaviors Observed for Azobenzene-based Photochromic Amorphous Molecular Materials

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Photomechanical behaviors observed for photochromic materials have been attracting a great deal of attention. Photomechanical bending motions of azobenzene-based liquid-crystalline polymer films and fibres, reversible photomechanical shape changes of needle- and plate-shaped microcrystals of photochromic compounds, and photo-induced surface relief grating (SRG) formation using azobenzene-based polymer films have been demonstrated. We have been performing studies of the creation of photochromic amorphous molecular materials, namely low molecular-mass materials that readily form amorphous glasses above room temperature, and in due course we have found several kinds of their photomechanical behaviours related with photoinduced mass transport.

In early stage of our studies, we have reported that SRG was formed by irradiation of the films of azobenzene-based photochromic amorphous materials with two coherent laser beams due to photoinduced mass transport. As related phenomena, the microfibers composed of azobenzene-based photochromic amorphous molecular materials have found to exhibit photomechanical bending motions, the bending direction being controllable by altering the polarization direction of the irradiated light. We have also found that relatively long-range mass flow could be induced at surface level of amorphous films of azobenzene-based photochromic molecular materials by angled irradiation using a p-polarized laser beam. In addition, the movement of the fragments of these molecular glasses could be induced by angled irradiation from their bottom as shown in Fig. 1. With regard to the hybrid systems, we have reported that phase-separation of the hybrid film of an

![Fig. 1. Photographs of fragments of BFIAB glass moving upon irradiation with p-polarized laser beam. Intensity of the laser beam: 30 mW. Incident angle: 20°. Scale bar: 50 μm.](image)
azobenzene-based photochromic amorphous molecular material with a quaternary ammonium salt could be induced by photoirradiation and that SRG composed of the quaternary ammonium salt by irradiation of the film followed by rinsing with hexane was demonstrated.\textsuperscript{5} The hybrid films of azobenzene-based photochromic amorphous molecular materials with poly(vinyl acetate) were found to exhibit thermally reversible phase separation and the resulting domain structures were deformed by irradiation with polarized laser beam.\textsuperscript{6}

Very recently, we have reported a novel photomechanical behavior observed for particles of azobenzene-based photochromic amorphous molecular materials fixed in agar gel.\textsuperscript{7} Upon irradiation of these particles in the agar gel with a linearly polarized laser beam, the shapes of the particles were gradually and drastically changed, being elongated parallel to the polarization direction of the incident laser beam to form string-like structures (Fig. 2). When stopping the irradiation, these string-like structures were maintained. It was found that the rates of elongation increased with the increase in intensity of the incident laser beam and in T\textsubscript{g} of materials. The phenomena were explained as follows: when the particles were irradiated with linearly polarized laser beam, photoinduced trans–cis and cis–trans isomerization reactions of the molecules took place, resulting in softening of the particles. Simultaneously, the molecules in the particles vibrated and/or moved in the direction parallel to the polarization direction of the incident beam. As a result, the particles pushed the surrounding gel away in the direction parallel to the polarization direction, resulting in elongation of the particles.

Reference