

**Nanopatterning of Azo-polymers:
Light Polarization and film thickness effects**

invited

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Polymers containing azobenzene derivatives have been the subject of intensive research for two decades owing to their unique “smartness”, i.e., the ability to tailor and/or control materials properties by photoisomerization. In particular, it was shown that photoisomerization creates optical anisotropy by nonpolar orientation, and poling by polar optical excitation (all optical poling), and it triggers molecular movement far below the glass transition temperature (T_g) of the polymer (photo-assisted poling), and polymer mass movement proceeds in spatial gradients of the excitation light (surface relief gratings). In solid polymers, photoisomerization of azobenzene derivatives creates free volume and drives efficient chromophore and polymer segmental and chain motion far below the polymer's T_g ; an effect which is at the origin of photo-assisted and all optical poling and surface relief gratings. Most of the studies reported to date on azo-polymers used single photon isomerization, and photoisomerization and photo-orientation can be achieved by two- or multi-photon isomerization with potential applications in nanophotonics. In this presentation, I will discuss our recent work on light induced molecular movement and induced plasticity in azo-polymers by a single focused laser beam that has a longitudinal field. Nanoscale polymer movement is induced by a tightly focused laser beam in an azo-polymer film just at the diffraction limit of light. The deformation pattern which is produced by photoisomerization of the azo dye is strongly dependent on the incident laser polarization and the longitudinal focus position of the laser beam along the optical axis. The anisotropic nanofluidity of the polymer film and the optical gradient force played important roles in the light induced polymer movement. The limits of the size of the photo-induced deformation were explored, and it was found that the deformation depends on the laser intensity and the exposure time. The smallest deformation size achieved was 200 nm in full width of half maximum; a value which is nearly equal to the size of the diffraction limited laser spot. We also found that the deformation patterns induced by a longitudinal field (E_z) were strongly dependent on polymer film thickness. The polymer formed a dip at the center of the focused spot when the film thickness is thinner than 37 nm while the polymer formed a protrusion when the film thickness is thicker than 37 nm. These results imply that upward and downward forces are competing inside the polymer film and the balance between them finally decides the surface topology (dip versus protrusion) of the film.