Since more than 20 years, optical interference patterns have been used to create permanent deformations of polymer films that contain azo-benzene chromophore units. Although the material remains below the glass temperature and is not chemically modified, one observes over a time scale of seconds to minutes that mass transport generates a surface relief grating with amplitudes beyond 100nm and a pitch in the micron range, set by the period of the illuminating light pattern. The basic photochemical process that drives the relief is the cyclic isomerisation of the azo-benzene moiety between the \textit{cis} and \textit{trans} conformations \cite{1}. The photochemical reaction happens on the fs scale and is accompanied by large-angle motion of the N=N bond. Within a fraction of a second, the azo-benzene groups are aligning themselves relative to the local optical polarisation. This process competes with mechanical interactions within the polymer architecture, related to the difference in proper volume of the azo-benzene conformations and depending on the location of the chromophore groups \cite{2}.

Our group is investigating the relief growth in real time by in-situ AFM and optical diffraction of a weak red probe beam that is not absorbed by the film. The diffraction pattern gives access to the topographic relief, refractive index and birefringence gratings in the polymer material. For the polymer studied here, mass transport sets in after a few seconds of irradiation, the material relaxing to some extent when the irradiation is stopped. The relief can be erased by illuminating with a homogeneous (single) beam or by heating. Our measurements provide correlations between topography and birefringence of the film and the optical interference pattern \cite{3}. The relief growth rate depends sensitively on the illuminating polarisation \cite{4}. Ellipticity gradients seem to be particularly efficient, in which case we also observe rapid (sub-second) fluctuations of the birefringence.


\cite{4} S. N. Yadavalli \& S. Santer, \textit{J. Appl. Phys.} \textbf{113} (2013) 224304

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