Understanding photo-induced deformations via optical feedback

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Polymer materials based on the azo-benzene chromophore respond to near-resonant irradiation with light typically in three steps: (1) trans-cis isomerisation that changes physico-chemical material properties, (2) orientation of photo-sensitive units, leading to bulk broad-band birefringence, and (3) deformation, leading in thin films to bending or surface relief formation [1, 2]. The time scales of these processes are specific to the material and differ substantially, indicating that energy is transported across a network of degrees of freedom, e.g., short- and long-range deformations of polymer chains.

The talk investigates the possibility of optical feedback to enhance film deformation and to understand its dependence on polarisation (gradients). Numerical diffraction calculations provide the holographic pattern across a film with a given topographic or birefringent structure [3]. The deformation is modelled based on a simple continuum mechanics model ("photo-striction") where light-induced stress and pressure respond to the light intensity and its polarisation tensor. Positive feedback occurs when photo-striction reinforces the considered surface relief. Similar considerations can be applied to bulk birefringence gratings [2]. The experimentally observed significant difference between s- and p-polarised intensity gratings is recovered in the model. The dependence on grating pitch and film thickness is compared to observations.

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References

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