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Utsunomiya Univesity Center for Optical Research and Education Toyohiko Yatagai

SURFACE RELIEF GRATING AND RETARDAGRAPHY: OPTICAL MANIPULATION OF AZOBENZENE POLYMER FILMS AND ITS APPLICATIONS

OPTICAL FUNCTIONAL DEVICES USING AZOBENZENE POLYMER FILM



- × Photoisomerization
- × Surface relief grating
- Retardagraphy: recording of optical polarization and reconstruction of complex amplitude
- Functional devices based on multilayer polymer thin film

PHOTOINDUCED MASS TRANSPORT



Nanofabrication, photo-mechanical devices



Photoinduced surface relief (PSR) formation

P. Rochon et al., Appl. Phys. Lett., 66, 136 (1995)

POLARIZATION DEPENDENT







10 µm



MULTIPLE RECORDING GRATINGS



Surface relief grating



Hexagonal structure



Orthogonal grating structure



Blazed grating structure

RELEIF DEPTH CONTROL BY ELECTRIC FIELD





COMPUTER SIMULATION BASED ON VISCOUS FLUID MODEL Navier-Stokes equation



Continuity equation $\frac{\partial \rho}{\partial t} = 0$

u: velocity vector

COMPUTER SIMULATION OF MASS TRANSFER



(532 nm)

Intensity:50 mW/cm²

Nd:YAG Laser $abla^2 oldsymbol{E} = - k^2 oldsymbol{E}$ E :Electric Field k :Wave number 1 µm

UU OPTICS

SUMMARY IN SURFACE RELIEF GRATING

- Origin of mass transfer: gradient of light intensity gradient of light pressure surface tension
- SRG generation is mainly due to electric dipole interaction with outer electric field.

PHOTOINDUCED BIREFRINGENCE



Optical storage media, polarization controllable devices

- Retardagraphy-

Optical recording technique for the retardance of a birefringent object

Liquid crystal spatial light modulator

Multivalued phase recording with a single laser beam

Large amount information recording





POLARIZATION HOLOGRAPHY: RECORDING





POLARIZATION HOLOGRAPHY: RECONSTRUCTION





POLARIZATION HOLOGRAPHY: RECONSTRUCTION







JONES CALCULUS





PRINCIPLE OF RECONSTRUCTION





PRINCIPLE OF RETARDAGRAPHY





PRINCIPLE OF RETARDAGRAPHY





EXPERIMENTAL SETUP



OPTICAL RECORDING BY RATARDAGRAPHY



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SUMMARY IN RETARDAGRAPY



•Explanation of polarization holographic characteristics in photoinduced birefringent films

Complex amplitude of signal beam from an object

Amplitude: Retardance of photoinduced birefringence Phase: Principal axis of photoinduced birefringence

Application to phase-type optical recording by retardagraphy

Features of retardagraphy

Recording absolute retardance values using a single laser beam
High robustness



MULTILAYER STRUCTURE BY SIPN COARTING











R. Katouf, T. Yatagai and S. Umegaki: Photonics & Nanostructure, **3**, 116(2005).



SUMMARY & PROPOSALS

Functional photo material: Azobenzene polumers

Photoisomerization

Surface relief grating: hologaphy & functional gratings

Photo-induced bifringence: retardagrapy, optical memory & polarization devices (polarization grating for LS devices)

Optical multi-layer structure: functional modulator

Collaboration: Joensuu University (Design of functional devices)