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A2-4 Reversible Optical Memory Effect due to Evaporation and Deformation of Organic Compounds

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The image-formation due to the evaporation and deformation of organic compounds caused by exposure to light has been known since 1840. An application of this effect to infrared hologlam formation was reported[1),2)] and it was clarified that deposition of films by evapolating organic compounds was difficult, spin-corting was an appropriate way of forming films, and that image-storing was rather difficult except when the organic compound was carbon ink or gelatin, because the image decayed after the end of exposure to the light until the organic compounds were cooled. The decay of the image could be restricted when the film was thin because the fluidity of the melted organic compound was small due to the adhesive power and viscosity; however, in this case, rewriting of the image is difficult because the thickness of the film decreases quickly due to evaporation.

In this report it is clarified that the fine unevenness of substrate surfaces makes uniform spreading of organic compounds on the substrates much easier and also makes image-storing much easier. A small lump of paraffin was put on the uneven surface of substrate, then the substrate was heated in order to spread part of the lump on the uneven surface to form an equi-thick paraffin layer. An argon ion laser was used as a light source. The thickness of the equi-thick paraffin layer could be kept at a fixed value due to the supplement of paraffin from the remainder of the lump. Rewriting is expected to be possible infinite times provided that the lump of paraffin is supplied after each several hundred times of rewritings.

Five different types of substrates were used in the present experiment. The structures of these substrates were 1) glass-In_2O_3-CdS, 2) glass-Au, 3) glass-Ag-Au, 4) glass-SnO_2-Ag, and 5) glass-Ag. The transparent electrodes, namely In_2O_3 layers and SnO_2 layers were used as heaters. The Ag layers were formed in order to make uneven surfaces. The thickness of the deposited Ag layers was about 300Å, and after the deposition of the Ag layers, the substrates were heat-treated. The heat-treatment caused fine unevenness in the Ag layers, in other words, the Ag layers were separated into small islands. The CdS layers and the thin Au layers were formed in order to increase the absorption of argon ion laser beam. The struc-

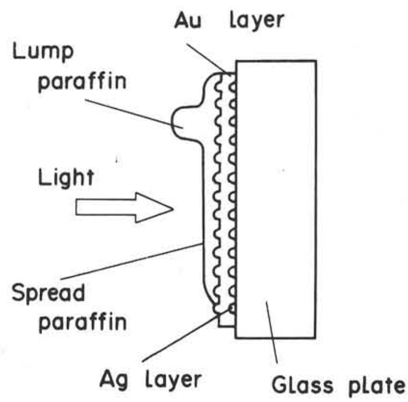

Fig.1 Structure of substrate 3)

ture of the substrate 3) is shown in Fig. 1

Only in the case of the substrates 3),4) and 5), paraffin spread wide and uniformly. The thickness of the spread paraffin on the substrate 5) is shown in Fig. 2 as a function of distance from the center of the lump of paraffin.

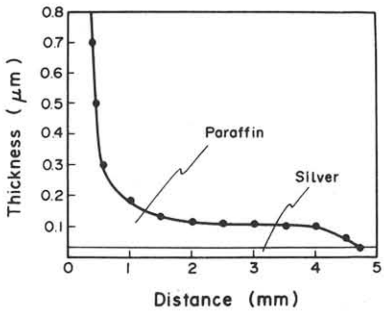

Fig.2 Thickness of spreaded paraffin

The resolving powers, when the time of exposure was 1 second and the thicknesses of the paraffin layers were about 1500Å, were 100 lines/mm for the substrate 1), which has slight unevenness in the surface, 50 lines/mm for the substrate 2), which has an even surface, and at least 200 lines/mm for the substrates 3),4) and 5), which have fine unevenness in the surface. Finer unevenness is necessary to improve the resolving power, and the improvement seems to be possible. The power density of the laser beam necessary for the image-formation was about $5W/cm^2$.

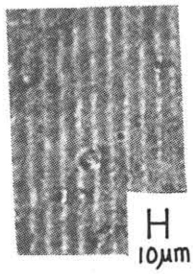

Fig.3 Microphotograph of a grating

Hologram was formed in the paraffin layer on the substrate 4). The microphotograph of formed grating taken by reflected light is shown in Fig. 3. The cross section of the grating seems to be in the form shown in Fig. 4. The amplitude of the grating was about 1200Å. The amplitude depends on the thickness of the paraffin layer. And the thickness of the paraffin layer depends on the shape of unevenness and on the temperature of the substrate-surface. No change was observed in the stored grating after 5 months storage at room temperature.

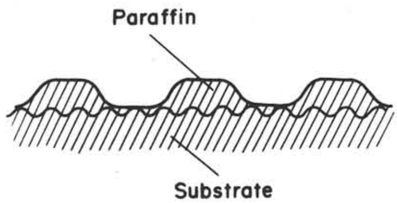

Fig.4 Cross section of a grating

The refractive index of the uneven surface layer of the substrate should be nearly equal to that of paraffin to avoid the disadvantage of unevenness of the surface to the diffraction efficiency, the heat-conductivity of the surface layer should be low, and its transmissivity for the reading-light should be high. CdS,Au or Ag are not the most appropriate material for the surface layer, The grating whose amplitude is about 1200Å is expected to give about 5~10% of diffraction efficiency when the disadvantage of the uneven surface of the substrate does not exist.

References

1) S. Kobayashi and K. Kurihara : Appl. Phys. Letters 19,482(1971).

2) K. Kurihara and S. Kobayashi : Fall Convention Record of Japan. Soc. of Appl. Phys., 1, p109,p110(1972).