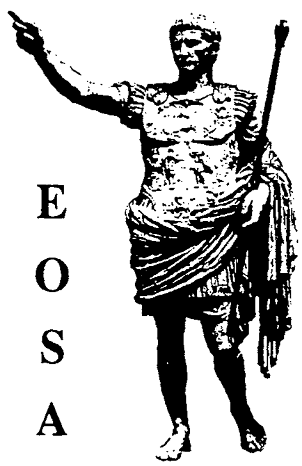
EUROPEAN OPTICAL SOCIETY

ANNUAL MEETINGS DIGEST SERIES: VOLUME 3 ISSN: 1022-0151

EOS

EOS ANNUAL MEETING

1993



E
O
S
A
M MCMXCIII

Zaragoza, 6 - 9 July 1993

Organised by: Universidad de Zaragoza

With the collaboration of: Sociedad Española de Optica

Sponsored by: Comisión Interministerial de Ciencia y Tecnología
Ministerio de Educación y Ciencia
Diputación General de Aragón
Ayuntamiento de Zaragoza
Universidad de Zaragoza
Academia de Ciencias de Zaragoza
iberCaja

EOS Annual Meetings Digest, Vol.3. Zaragoza 1993.

THE NON-LINEAR RESPONSE OF DYE-SENSITIVE PHOTOPOLIMERS IN REAL TIME HOLOGRAPHY

A. Fimia, A. Beléndez, N. López, L. Carretero

Laboratorio de Optica, Departamento Interuniversitario de Optica, Universidad de Alicante, Apartado 99, Alicante 03080, Spain.

R. Sastre, J. Pineda

Instituto de Ciencia y Tecnologia de Polimeros, C.S.I.C., Madrid.

F. Amat-Guerri

Instituto de Quimica Organica General, C.S.I.C., Madrid.

ABSTRACT

Photopolymers are considered today one of the most promising recording materials for Holography because with them it is possible to achieve high diffraction efficiencies and low signal-to-noise ratios, while working in real time. Moreover, they are self-developing materials. In this comunication we propose a non-linear model that, using the accepted mechanism of most photopolymerization reactions as a starting point, justifies the non-linear response of the diffraction efficiency curve, when these recording materials are analysed in real time.

PHOTOPOLYMERIZATION MODEL

Photopolymers are holographic recording materials which store information through refractive index variations under irradiation. This index changes according to the composition of the materials used and to the mechanism of the photopolymerization reaction involved. If a photochemical polymerization changes the concentration of the initial monomer A, producing polymer B, the relation betwen the concentration of A and B at any time, t, is:

$$C(B,t)=C(A,t)\,(1-\exp(-kt))$$

where k is the overall reaction rate, a constant related to the photochemical quantum yield and to the absorbed radiation intensity. Assuming that refractive index and concentration are related through the Lorentz-Lorenz expresion, it is possible to deduce the behavior of the modulation index as a funtion of the parameters above defined (expresion (1)). Figure 1 shows an example of this relation.

$$\Delta n(t) = \frac{(n^2+2)^2}{6000n} C(A,0)\,(R(B) - R(A))\,(1 - \exp(-kt)) \qquad [1]$$

R(A)and R(B) are the molar refractions of monomer and polymer and n is the refractive index of the photopolymer. As it is seen, a clear non-linear relation is established between exposure and modulation index. Previous studies have shown that this function is possible[1], but the relation between the photochemical reaction and its form has not been justified.

DIFFRACTION EFFICIENCY

Taking into account that that diffraction gratings are stored in real time in photopolymers, and that the diffraction efficiency for phase holograms follows the equation proposed by Kogelnik[2], this diffraction efficiency, η, for non-linear responses of photopolymers can be expressed by (2):

$$\eta = \sin^2\left(\frac{\pi d}{\lambda \cos\theta}\Delta n(t)\right) \qquad [2]$$

Figure 2 shows that the diffraction efficiency does not have a periodic responses as predicted by Kogelnik´s model, because the behavior of the modulation index is non-linear. At high exposures, diffraction efficiency remains constant.The equation described above also indicates the existence of a clear relation between composition and properties of the materials on one hand, and the diffraction efficiency obtained on the other. Likewise, it allows the optimization of the material according to its composition, quantum yield and irradiation intensity.

CONCLUSION.

Using Kogelnik's theory and introducing the non-linear response of refractive index modulation caused by the concentration changes in photopolymerization reactions, we have proven that photopolymerizable materials have non-linear behavior when working in real time Holography.

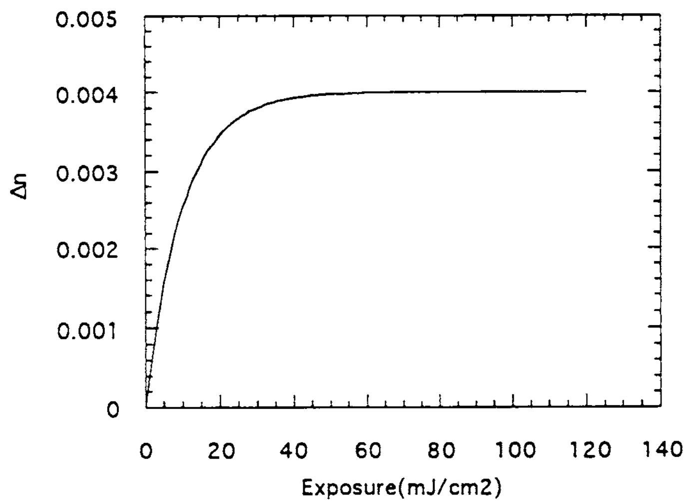


Figure 1

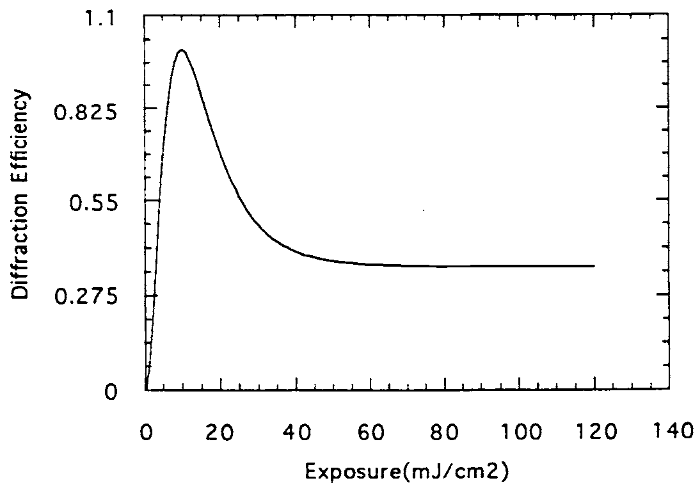


Figure 2

REFERENCES

[1] P. Markovski, T. Todorov and N. Koleva, Opt. Quantum Electron., **16**, 19, (1984).

[2] H. Kogelnik, Bell. Syst. Tech. J. **48**, 2909 (1969).