Chemistry and Sustainable Development

6th ANQUE International Congress of Chemistry

Puerto de la Cruz, Tenerife (Spain)

5-7th December 2006

ASOCIACIÓN NACIONAL DE QUÍMICOS DE ESPAÑA

ANQUE

Volume 2
Abstracts Book

C/ Lagasca, 27 1º E – 28001 Madrid (Spain)
Tel.: 91 431 07 03 – Fax: 91 576 52 79
www.anque.es

Printed by Gráficas DEVA
Arganda del Rey (Spain)
ISBN: 84-690-2349-7
D.L.: M-47091-2006
December 2006

NEW PHOTOPOLYMERS WITH LOW LEVEL OF TOXICITY

M. Ortuño[1], A. Márquez[1], S. Gallego[1], E. Fernández[2], C. Neipp[1], A. Beléndez[1], I. Pascual[2]

1. Departamento de Física, Ingeniería de Sistemas y Teoría de la Señal
2. Departamento Interuniversitario de Óptica

mos@ua.es, tlf.: 965903400, ext.: 3327, Universidad de Alicante

T2.1 Contribuciones de la química y de la ciencia y tecnología de materiales

Introduction

Photopolymers are materials used as photosensitive recording media. The light initiates several processes and chemical reactions to change some properties of the material such as the refraction index. In a holographic recording process two beams of light interfere, producing a pattern of interference fringes onto the photosensitive material, and a diffraction grating is recorded. In the photopolymer the diffraction grating generated is stored by means of the polymerisation of the monomer in the bright zones [1].

The hydrophilic photopolymers based in acrylamide (AA) as polymerizable monomer have important advantages such as their easy production, they do not need post-processing, they have low cost and good characteristics as holographic recording medium [2]. These properties are very interesting for a wide spectrum of applications such as for holographic optical elements, holographic memories, or as a recording medium in photochemistry studies based on holographic techniques.

These materials have an important disadvantage if we consider their environmental characteristics. AA is a very toxic substance with carcinogenic properties so the production of these materials must be made carefully. Moreover, the photopolymer has a potential toxicity before recording because AA is toxic until is polymerised. Furthermore, after holographic recording, a part of AA is not polymerised as polyacrylamide.

In this work we consider the possibility of substitution of AA by acrylic acid based monomers whose toxic potential is lower. For this analysis we produce a series of solid layers of photopolymer with the same thickness (800 μm) and containing different monomers: AA (composition A), acrylic acid (composition B), and sodium acrylate (composition C). To compare the differences between the materials unslanted diffraction gratings are recorded with a spatial frequency of 1125 lines/mm using a holographic set-up with an argon laser as recording laser (514 nm) and a He-Ne laser (633 nm) for the reconstruction of the holograms recorded.

Experimental

The A photopolymer (AA based) it is typically developed by our research group, serving as the reference material in this study. In B photopolymer the AA is substituted by acrylic acid as monomer. In the C photopolymer the acrylic acid is transformed in sodium acrylate, that is the polymerizable active monomer, by means of the reaction of acrylic acid with sodium hydroxide during the preparation of the start solution. The radical generator is triethanolamine (TEA), the dye is yellowish eosin (YE) and the binder is polivinyl alcohol (PVA).

Each solution is deposited in polystyrene molds, and left in the dark (relative humidity=47-60%, T=24-25 ºC). When part of the water has evaporated (about 6 days), the layer has enough mechanical resistance and it can be extracted from the mold without deformation. The solid film is cut into squares and adhered, without the need for adhesive, to the surface of

glass plates measuring 6.5×6.5 cm^2. The plates are then ready for holographic exposure, which takes place immediately.

Results

Figure 1 plots the diffraction efficiency versus the angle of reconstruction. The B photopolymer reaches a maximum diffraction efficiency (DEmax) of 7.66%, lower than the material with AA (A photopolymer) which achieves a DEmax= 71.43%. This result is due to the concentration of acrylic acid in the B photopolymer, lower than the theoretical value, because this monomer evaporates with the water during the process of preparation of the material. Thus, the value of DEmax obtained is due to a residual concentration of acrylic acid in the material.

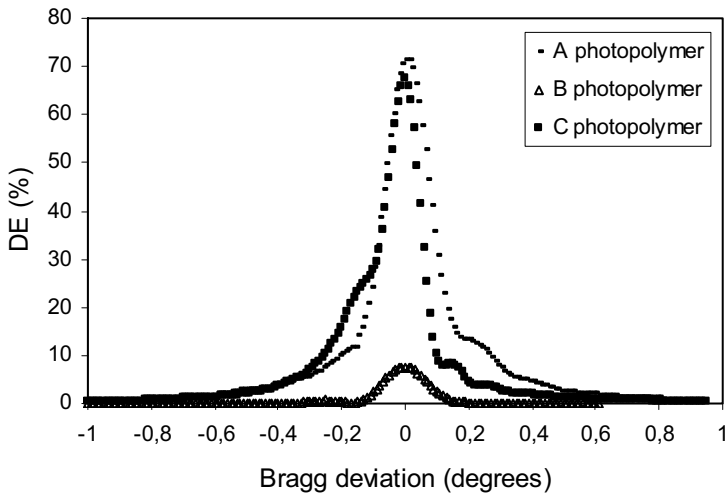

Figure 1. Diffraction efficiency versus the angle of reconstruction for the A, B and C photopolymers.

The situation changes outstandingly for the C photopolymer, DEmax= 67.53%, which is close to the values for the A photopolymer and higher than the obtained for B photopolymer. This high value is due to the content of sodium acrylate, constant during the drying process, and because of the adequate reactivity of this monomer, allowing for a radical chain polymerisation which generates chains of sodium polyacrylate.

The values of energetic sensitivity (S) (energy necessary to reach the DEmax value) are very similar S_A= 67 mJ/cm^2, S_B= 62 mJ/cm^2, S_C= 39 mJ/cm^2. The losses by absorption, dispersion and reflection, including the glass support where the layers are adhered, are very similar for the 3 materials: about 20% of the incident intensity.

Acknowledgment

This work was supported by Ministerio de Educación y Ciencia (FIS2005-05881-C02-01, FIS2005-05881-C02-02) and Generalitat Valenciana (GV06-007), Spain.

References

[1] R. A.Lessard, G. Manivannan, “Selected Papers on Photopolymers: Physics, Chemistry and Applications”, T. J. Trout, ed., Proc. SPIE 114 (1995).
[2] M. Ortuño, S. Gallego, C. García, C. Neipp, I. Pascual, Appl. Opt. 42 (2003) 7008.