SELF-PHOTOPATERNABLE DI-UREASIL-ZIRCONIUM OXO-CLUSTERS ORGANIC-INORGANIC HYBRIDS FOR LOW COST INTEGRATED OPTICAL SUBSTRATES

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The exploitation of the potential applications of the so-called organic/inorganic hybrids in many different areas, including integrated optics (IO), has been presented during the last years [1]. The simplicity and low cost of the sol-gel process make this method very suitable for the development of organic/inorganic hybrid materials for the production of functional IO devices [2]. Among the various organic/inorganic hosts that have been developed in the last years, those containing amine functionalities, namely urea cross-linked hybrids classed as di-ureasils (Fig. 1) present acceptable transparency, mechanical flexibility and thermal stability to be processed as IO substrates [3-5]. In particular, distributed feedback lasers (DFB) by using dynamic gratings have been demonstrated for di-ureasil thin films incorporating rodhamine 6G [3]. Diffraction gratings, channel and monomode planar waveguides with low propagation losses, both in the infrared (0.6-1.1 dB/cm) and in the visible (0.4-1.5 dB/cm), were fabricated using the synergism between two hybrid precursors (di-ureasil and methacryloxypropyltrimethoxysilane) and methacrylic acid (McOH, $CH_2=C(CH_3)COOH$)) modified zirconium tetrapropoxide, $Zr(OPr^n)_4$ [4,5].

New perspectives for the development of innovative IO devices, such as low-cost optical power splitters for the general use spreading of all optical access networks, for instance, are therefore envisaged. The requirement of larger bandwidth may be attained by the development of access networks based on optical technology, such as passive all-optical networks (PONs) operating at high bit rate optical signals (40 Gbits/s). This will require low cost components to operate in the infrared spectral region, typically at 1550 nm. Examples of applications being narrow band optical filters (used as demultiplexers to access the desirable wavelengths in a multi-wavelength system), low losses optical power splitters, and optical cavities (for the optical clock extraction function). A window of opportunity for sol-gel derived components is therefore opened.

In this work, di-ureasil hybrids containing McOH modified $Zr(OPr^n)_4$ are prepared and structurally characterized by X-ray diffraction (XRD), small angle X-ray scattering (SAXS), Fourier transform infrared (FT-IR) and Raman spectroscopies, ^{29}Si and ^{13}C nuclear magnetic resonance (NMR), and atomic force microscopy (AFM). XRD and SAXS results point out the presence of Si- and Zr-based nanobuilding blocks (NBBs) dispersed into the organic phase [5]. Furthermore, monomode waveguides, diffractions gratings, and Fabry-Perot cavities are written through the exposure of the hybrid monolith to UV light [5]. The guidance region in patterned channels is determined as a Gaussian section located below the exposed surface. The number of propagating modes, the refractive index gradient and the maximum index contrast are analyzed. Moreover, the reflection coeficient the of the Fabry-Perot cavity (formed by a grating patterned into a 0.278 cm channel) and its free spectral range value will be estimated [5].

[1] C. Sanchez, B. Julian, O. Belleville, M. Popall, J. Mater. Chem. **15** (2005) 3559.
[2] *Functional Hybrid Materials*, P. Gomez-Romero, C. Sanchez, Eds.; Wiley Interscience: New York, 2003.
[3] D. C. Oliveira, Y. Messaddeq, K. Dahmouche, S. J. L. Ribeiro, R. R. Gonçalves, A. Vesperini, D. Gindre, J.-M. Nunzi, J. Sol-Gel Sci. Techn. **40** (2006) 359.
[4] C. Molina, P. J. Moreira, R. R. Gonçalves, R. A. S. Ferreira, Y. Messaddeq, S. J. L. Ribeiro, O. Soppera, A. P. Leite, P. V. S. Marques, V. de Zea Bermudez, L. D. Carlos J Mater Chem **15** (2005) 3937.
[5] D. C. Oliveira, A. G. Macedo, N. J. O. Silva, C. Molina, R. A. S. Ferreira, P. S. André, K. Dahmouche, V. de Zea Bermudez, Y. Messaddeq, S. J. L. Ribeiro, L. D. Carlos, submitted.

Figures:

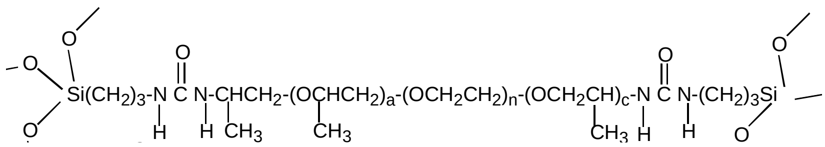

Figure 1. Molecular Structure of the di-ureasil hybrid (a+c=4.5, n=8.5).