A Study of the Thermal and Optical Properties of Opals by the Photothermal Deflection Technique

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The use of opals in many new devices requires the lowest available thermal conductivity value in order to decrease the switching power and switching time. Thus, the fundamental role of the experimental determination of the thermal and optical properties of opals is evident. The photothermal deflection technique represents a unique non-desctructive and non-contact method usable to determine these properties. In this article, we have applied this technique, in two different configurations, to different SiO_2/GaN opals obtained by assembling SiO_2 spheres with diameters of about 650 nm, and by infiltrating GaN with them at different percentages [1].

Concerning the optical characterization, since both SiO_2 and GaN are transparent (i.e. non-absorbing) for wavelengths larger than 400 nm, a negligible absorption for the opal SiO_2/GaN is expected. Moreover, these opals are strongly scattering, so that it is difficult to apply traditional spectroscopic techniques. For these reasons, photothermal deflection spectroscopy has been chosen to determine both absorption and scattering spectra in the range from 350 to 1150 nm [2]. From the measurements, a strong increase in optical scattering has been observed when the optical wavelength becomes on order of the sphere size.

Concerning the thermal characterization, a different photothermal deflection setup has been applied to determine the effective thermal diffusivity of the opals [3, 4]. From the experimental results, one may suppose how the thermal boundary resistances at the interfaces could limit the effective thermal properties of the entire structure.

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