Cent. Eur. J. Phys.
DOI: 10.2478/s11534-009-0121-x

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Central European Journal of **Physics**

On the modulation frequency dependence of the photoacoustic signal for a metal coated glass-liquid system

Research Article

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Received 21 May 2009; accepted 20 July 2009

Abstract: We show that the front photoacoustic signal due to a sample consisting of a glass plate with a metal coated surface, at which thermal waves are generated by periodical light absorption, enhances for certain modulation frequencies when the other glass surface is covered with a liquid sample. This contradicts the intuitive expectation based on the assumption that the liquid provides a new channel for heat conduction thereby decreasing the substrate temperature. Experimental results are shown and the described effect is explained using a thermal wave interference model.

PACS (2008): 42.25.Hz, 43.58.+z, 44.90.+c, 65.20.-w, 66.10.cd

Keywords: photoacoustic • coatings • thermal waves • heat transfer

1. Introduction

The photoacoustic (PA) technique is a well established method for thermal characterization of condensed matter samples and several experimental configurations have been proposed in the past. In one of them, an optically opaque sample covers one of the two openings of a PA cell, while the other is closed by a transparent glass window through which a modulated light beam impinges on the inner sample surface generating periodical heating (the so-called thermal waves) and hence a pressure fluctuation, which can be detected with a microphone already enclosed in the PA cell. This is an open cell configuration in the sense that the sample is placed in the outer part of the PA chamber. This kind of configuration has been used in the past for: i- thermal effusivity measurements in solids [1] and liquids [2] in good thermal contact with the non-illuminated surface of the sample, acting in this variant as a reference; ii- for specific heat capacity measurements in the sample itself using the liquid as a reference [3, 4]; and iii- for the monitoring of dynamic processes taking place at the sample-liquid interface, such as those described recently by Lima *et al.* [5].

To warrant full absorption of the light beam in the case of transparent samples, their inner surfaces are often coated by a thin opaque metal film, where heat will be thus generated. For this configuration we have observed that the PA signal due to a liquid sample onto the glass metalized

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