Heat capacity measurement in solids by means of the photoacoustic technique

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Abstract. We report a method for determining the specific heat capacity in solids by means of the photoacoustic (PA) technique in a heat transmission configuration. This method involves a modulation frequency range where the samples are thermally thin and a liquid (i.e., distilled water) as a reference sample. It is free of PA cell parameters and was tested in some metals and semiconductors. The results agree very well with literature reported values for these samples.

1. INTRODUCTION

There are several methods for the practical determination of heat capacity per unit volume (\(c_p\)). Some of them are discussed in detail in Ref. [1], while in Ref. [2] an excellent overview of the most useful calorimetric and thermal methods is given. In the last years we have witnessed the development of Photoacoustic (PA) methods [3] for measurement of the thermal properties of materials. As to the best of the author’s knowledge none of the existing PA methods in a heat transmission configuration allows the direct measurement of the heat capacity per unit volume at room temperature of solids, in this paper we propose a novel variant of the PA technique for this purpose.

2. METHOD AND EXPERIMENTAL RESULTS

A light beam is modulated at a variable frequency \(f\) and uniformly focused onto a sample after it have passed through a transparent liquid layer used for reference purposes (this reference is held onto the sample’s surface by means of a Teflon O-Ring). The sample-reference system closes a 5.5 millimeter diameter opening of a 3 millimeter long cylindrical cell cavity. The modulated beam is absorbed by the sample of thickness \(l_s\), and the generated heat propagates into the liquid as well as through the sample towards the PA chamber. The air pressure oscillations, \(\Delta P\), generated within the PA chamber are sensed by a sensitive condenser microphone connected to the cell’s air chamber through a 1mm wide duct located in the cell wall. A lock-in amplifier interfaced with a personal computer is used to measure the microphone response signal.