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The application of the temperature wave technique for investigation of the influence of the magnetic field on the acoustic properties of water

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Abstract

The temperature wave technique lets to estimate the effect of a magnetic field on the acoustic properties of water and aqueous solutions. For this purpose a series of comparative experiments with and without of the magnetic field was conducted. The value of inhomogeneous magnetic field B in the sample was about 0.27 T. The experimentally observed changes of the speed of sound, amplitude or shape of the acoustic signals allow us to conclude about the change of chemical or structural properties of the investigated substance.

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Keywords: temperature wave technique; acousto-optic technique; water; speed of sound; influence of the magnetic field; sonolis.

1. Introduction

In the earlier works [Ueno et al. (1994), Iwasaka et al. (1998), Hosoda et al. (2004), Ghauria et al. (2006)] the changes of refractive index for water solutions and its salts under the influence of strong magnetic fields ($B \leq 16$ T) were investigated. It was recorded minor changes in refractive index n (at the level of measurement errors) at high fields. The authors concluded about certain changes in the structure of these liquids, probably conditioned by the appearance of additional hydrogen bonds. In this paper we used an acousto-optical method to reveal the effect of a constant inhomogeneous magnetic field ($B \leq 0.3$ T) on the acoustic properties of water [Melekhov et al. (2010)].

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2. Experimental setup and methods

Experiment is based on registration of sound waves in liquids by means of the acousto-optic technique (method of the fotodeflection) [Golyamina. (1978)]. The experimental setup (Fig.1) consists of a RF pulse generator, semiconductor laser, the cuvette assembly which is placed in the thermostat, photodetector and fast ADC.

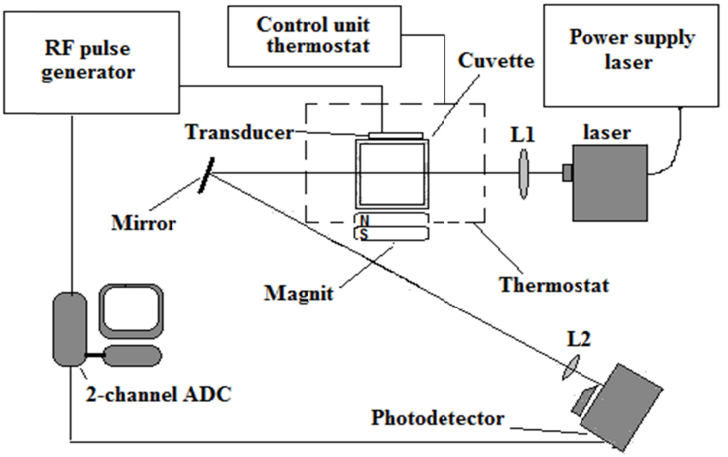
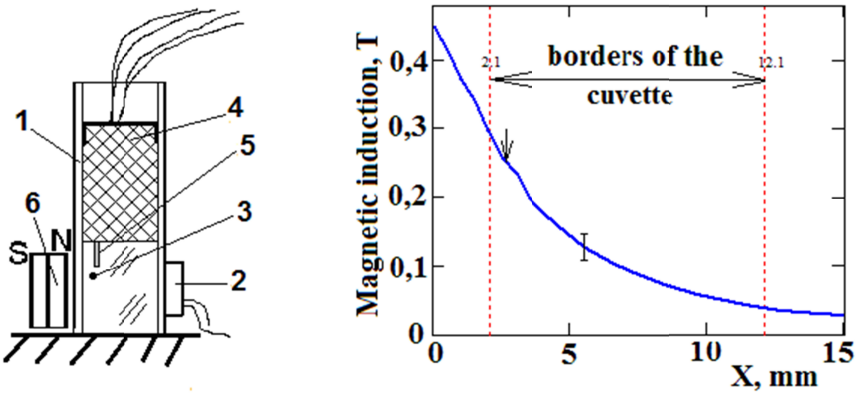


Fig. 1. Experimental setup

Parameters of the RF pulse generator: 1) the carrier frequency of f= 7.91 MHz; 2) the pulse duration t≈ 33 us; 3) the average acoustic power $Psr \leq 2 \cdot 10^{-4}$ W and 4) pulse power of the acoustic signal $Pimp \leq$ 0.18 W. The characteristics of the semiconductor laser: wavelength λ = 650 nm, power P = 1.3 mW, the divergence about 1 mrad. Focal length of the lens L1 is F=195±5 mm. The laser beam modulation was detected by means of the photodetector on the basis of pin-photodiode FDUK-5CT [www.technoexan.ru]. The signals registration were carried out by fast 2-channels 8-bit ADC with sampling speeds of up to Fs=250 MSPS.

Fig.2 shows the design of the cuvette assembly and the magnetic field distribution inside the cell.



a) b)

Fig. 2. The geometry of the cuvette assembly (a). The dependence of the magnetic induction of the distance X. The arrow points to the value of the field in the region of the laser beam (b).