

Photoacoustic Characterization of Natural Mineral Pyrite (FeS_2)

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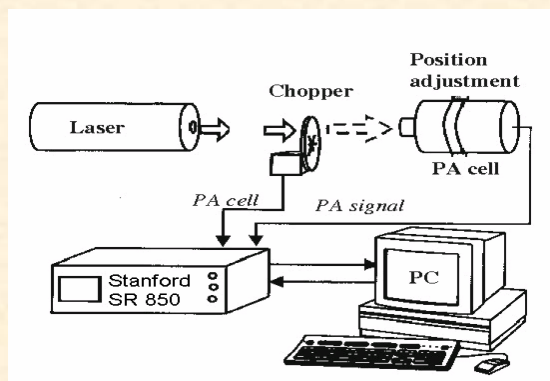
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Introduction

Iron pyrite (FeS_2) is a natural mineral with a cubic elementary cell $\text{Pa}\bar{3}$ and lattice constant $a=5.416 \text{ \AA}$ [1]. Pyrite has potential for use in lithium batteries [2] and for thin solar cells [3]. It's electronic and optical properties were recently studied [4].



PA measuring equipment

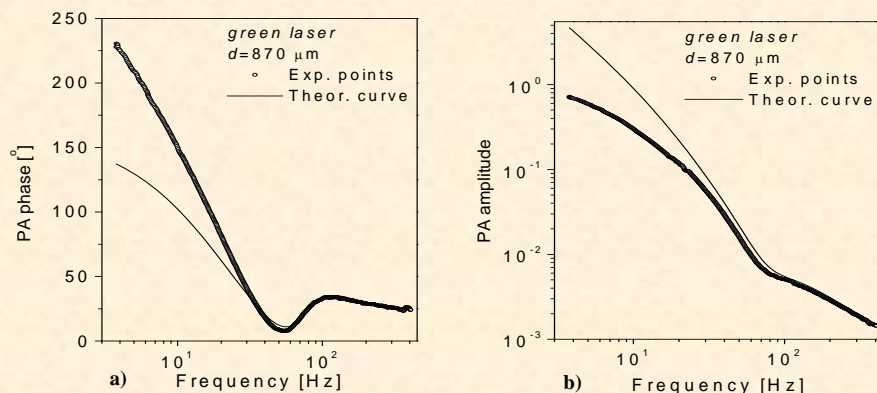


Fig. 1. Experimental and theoretical (full line) PA amplitude (a) and phase (b) diagrams for the pyrite sample $870 \mu\text{m}$ thick

Experimental

Single crystal p-type samples of this mineral from the Novo Brdo mine in Serbia was cut parallel to the [210] plane. The samples were disc shaped with a diameter about 9 mm and thickness less than 1mm. Photoacoustic (PA) amplitude and phase spectra versus the modulation frequency were measured using a transmission detection configuration with red and green lasers. In Fig.1 the experimental results obtained with a green laser are given with circles. The theoretical curve is given with a full line. It was analysed using a modified Rosencwaig- Gersho thermal piston model [5]. The experimental and theoretical diagrams are different in the frequency range below about 40 Hz where the electret microphone sensitivity is decreased.

The calculated parameter values are given in Table 1 where D_T is thermal diffusivity, τ excess carrier lifetime, D the diffusion coefficient of the minority carriers, α the optical absorption coefficient, s_f and s_b are the front and rear surface recombination velocities. The value for the minority free carrier mobility is $1080 \text{ cm}^2/\text{Vs}$ that is much higher than the literature value of $230 \text{ cm}^2/\text{Vs}$ [6] obtained for polycrystalline samples.

Table 1. The values of parameters obtained by the fitting procedure for PA spectra of pyrite using the green laser

d [μm]	D [m^2/s]	D_T [m^2/s]	τ [μs]	α [m^{-1}]	s_b [m/s]	s_f [m/s]	μ_n [cm^2/Vs]
870	0.27×10^{-2}	0.65×10^{-5}	19	9520	11.2	115	1080

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