Photoacoustic Method for Characterization of Natural Galena (PbS)

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The thermal and some electrical transport properties of galena were investigated using the photoacoustic (PA) frequency transmission technique.

Single crystal and polycrystalline natural galena samples originated from the Trepča mine, Serbia. The thermal and free carrier transport properties and thermal diffusivity were obtained from PA measurements at room temperature. Single crystal natural galena was cleaved into plates; less than 1 mm thick, parallel to the (100) plane. Using an X-ray diffractometer only peaks corresponding to the following planes were observed: (200), (400) and (600). The lattice parameter calculated for a single crystal of galena was a=5.936 Å and free carrier concentration was measured as $N=3\times10^{18}$ cm^{-3}.

Samples were also cut from a polycrystalline mass of galena. All samples were of disc shape with a diameter of about 9 mm and mounted directly on the front of an electret microphone which had a 3 mm diameter circular hole as the sound inlet. The X-ray powder work showed that this sample of polycrystalline galena was doped with sphalerite but its lattice parameter was not changed.

The phase and amplitude PA signals versus the modulation frequency are given for three different single crystal sample thicknesses. The cleaved sample of 745 μm thick was polished down with silicon carbide P 1000 sand paper, on the back side in order to obtain progressively thinner samples. The cleaved shiny front side was in contact with the electret microphone, while the side roughened by polishing was exposed to the laser beam.

Our experimental results were analyzed using a theoretical model, involving the gas-sample-backing-microphone detection configuration [1,2,3,4].

The values of the following parameters for single crystal galena were calculated: diffusion coefficient of minority free carriers (D), excess carrier lifetime (τ), front surface recombination velocity (s_g), rear surface recombination velocity (s_b), optical absorption coefficient (α) and thermal diffusivity coefficient (D_T). The thermal diffusivity D_T was about 0.16×10^{-5} m^2/s. The diffusion coefficient $D=0.158\times10^{-2}$ m^2/s, applied to room temperature conditions. Using this value the room temperature mobility of the minority free carrier μ_n=625 cm^2/Vs was calculated and found to be in good agreement with the literature data for single crystal galena (μ_{n293K}=610 cm^2/Vs) [5].

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