INTERPRETATION OF THE PIEZO-PAS SPECTRA OF AII-BVI COMPOUNDS WITH A MODIFIED JACKSON-AMER EQUATION

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The presentation comprises the list of the following AII-BVI compounds: CdSe, ZnTe, ZnSe, ZnMgSe, ZnBeSe.

The aim of the investigations was to analyze the photoacoustic piezo-detected spectra measured at RT. The analysis comprises both the amplitude and phase spectra obtained at different modulation frequencies.

The PZT PAS results were interpreted with the following tools: the general temperature distribution equation $T(x,\beta,\alpha,\lambda, f, R)$, Jackson-Amer equation, different multi-layer models of the samples developed for the purpose of interpretation of the piezo-detected spectra.

The basic optical parameters of the samples were determined from the fitting of the theoretical curves to both the amplitude and phase experimental spectra.

The series of multi-layer models of the samples are presented and their role in the interpretation of PZT PAS results is discussed.

**The model of heterogeneous sample - the case of Zn$_{1-x}$Be$_x$Te.**

The model of a real crystal consists of two crystals exhibiting the parameters: $E_{g1}=2.293\text{eV}, E_{g2}=2.383\text{eV}$, $\beta_{01}=\beta_{02}=80$ cm$^{-1}$, $\gamma=0.4$, $\alpha=0.1\text{cm}^2\text{s}^{-1}$, $f=36$ Hz, $r=0.024\text{cm}$, $\Delta l=\Delta 2=1/200\text{cm}$, $R=-1$, $k=0.3$.

1) Zn$_{0.99}$Be$_{0.01}$Te
2) Zn$_{0.9}$Be$_{0.1}$Te

The amplitude spectrum of ZnSe at RT $f=16$ Hz. Solid line $R=1$, dash – $R=-1$, circles – experimental results.

The optical parameters of ZnSe determined from the fitting: $E_g=2.75\text{eV}$, $\beta_0=130\text{cm}^{-1}$, $\alpha=0.2\text{cm}^{-1}\text{eV}^{-1/2}$, $\omega=0.1\text{cm}$.

The schematic diagram of an inactive layer model.

1) inactive layer of a thickness $\Delta$  
2) proper sample region

$I_0$-intensity of light illuminating a sample $I_1$-intensity of light illuminating the proper sample. Assumptions: optical energy absorbed in the layer 1 is not transmitted to the region 2 – $R_{12} = -1$. The temperature distribution in layer 1 does not bring contribution to the piezo signal!

$I(h \cdot v) = I_0 \cdot (1 - \frac{1}{\beta} \exp(-\beta(h \cdot v) \cdot x) \cdot \beta(h \cdot v) \cdot dx)$

The influence of a thickness $\Delta$ of an inactive layer on the amplitude spectra of ZnSe.
Δ=0 cm (solid), Δ=0.0005 cm (dashdot), Δ=0.0014 cm (dash).

**EXAMPLE PHOTOACOUSTIC SPECTRA OF Zn(0.74)Be(0.26)Se annealed not polished.**

The case of the strong surface destruction Δ=1/200 cm being the result of annealing of the crystal. The crystals exhibit α=0.01 cm²/sec and fast beryllium escape from the crystal.

**THREE LAYER MODEL**

**Zn**₀.₇₅ **Mg**₀.₂₅ **Se**

\[ R = -1 \quad \text{and} \quad R = 1 \]

F=16 Hz, Δ=0.005-0.015cm, Eg=3.0eV, β0=80, γ=0.2, Λ₀=800, α=0.03.

\[ \text{Eg}=2.7 \text{ eV} \alpha=0.1! \] The rest parameters the same.

**The schematic diagram of a sample in a three layer model.**

Description: Layer 1 – an inactive layer \( R_1 = -1 \), \( R_{23} = 0 \), layer - 2 a depletion \( R_2 \) or enriched layer \( R_2 \), layer 3- the main body of the crystal exhibiting the \( R_3 \) characteristics.

**The correlations between intensities in the model.**

\[ I_0(h\nu) = 1, \]

\[ I(h\nu) = I_0 \cdot \left(1 - \frac{3}{\Delta} \exp(-\beta_1(h\nu) \cdot x) \cdot \beta_1(h\nu) \cdot dx\right) \]

\[ I'(h\nu) = I(h\nu) \cdot \left(1 - \frac{\Delta}{\Delta_2} \exp(-\beta_2(h\nu) \cdot x) \cdot \beta_2(h\nu)dx\right) \]

\[ I(2(h\nu)) = I_0(h\nu) \cdot (1 - \frac{2}{\Delta} \exp(-\beta_2(h\nu) \cdot x) \cdot \beta_2(h\nu)dx) \]

\[ T(x') = \frac{I'(h\nu) \cdot (\exp(-\sigma \cdot x') + R \cdot \exp(-2 \cdot \sigma \cdot l + \sigma \cdot x'))}{\lambda \cdot \sigma \cdot (1 - R \cdot \exp(-2 \cdot \sigma \cdot l))} \]

\[ T'(h\nu) \cdot (\exp(\sigma \cdot (l-x')) + R \cdot \exp(-\sigma \cdot (l-x'))} \]

\[ \lambda \cdot \sigma \cdot (\exp(\sigma \cdot l) - R \cdot \exp(-\sigma \cdot l)) \]

**Modelling of the changes of Zn(x)Mg(1-x)Se spectrum in the process of annealing.**

\[ \text{1) } \Delta_2 = 0 \quad \text{2) } \Delta_2 = 1/500 \text{ cm} \quad \text{3) } \Delta_2 = 1/200 \text{ cm} \quad \text{4) } \Delta_2 = 1/100 \text{ cm} \]