# SOME NEW PHYSICAL PROPERTIES OF $Al_2In_{12}S_{21}$

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The first data about $Al_2In_{12}S_{21}$ were reported at the 1976 Rome Semiconductor Conference [1]. Some physical properties of $Al_2In_{12}S_{21}$ were presented by Etlinger[2], Etlinger et al.[3], and Popović et al.[4]. In this paper we present some new physical properties of $Al_2In_{12}S_{21}$.

## Density

Density of $Al_2In_{12}S_{21}$ was determined by the use of two methods: by pycknometer and geometrical and weight measurements. The values were in good agreement and thus the density value was obtained.

$$= (4.32 \mp 0.10)\ g/cm^3 \qquad (1)$$

## Microhardness

Microhardness was measured at the room temperature by Vickers method. A small diamond pyramid with an angle of $136^o$, and 50 grammes of weight was used. The measurements were performed with monocrystal grains of polycrystal material. The mean value of diagonals was:

$$\bar{d} = (20.06 \mp 0.22) \times 10^{-6}\ m \qquad (2)$$

and appertaining microhardness value in Vickers tables[5] was:

$$\text{microhardness (Vickers)} = (230 \mp 3)\ kg/mm^2 \qquad (3)$$

Number of dislocations

The number of dislocations per $cm^2$ was determined by the use of metallographic microscope. The samples surfaces were first polished and then eched with HCl + $HNO_3$ (1 : 1) for one minute. The etch pits are equilateral triangles in ⟨111⟩ direction and their numbers per $cm^2$ is:

$$1750 \mp 250 \qquad (4)$$

Melting point

Melting point was obtained by observing the crystal surface at the time of crystal growth by SSD method[2]. The obtained value was:

$$T_{MP} = 1353 \pm 15 \quad (K) \qquad (5)$$

Specific heat

Specific heat was calculated by classic measurements in a small copper calorimeter which was firstly gauged by the means of well known specific heat materials (Fe, Cu, Al), and by using Richman rule:

$$m_1c_1(t_1 - \tau) = m_2c_2(\tau - t_2) + m_3c_3(\tau - t_2) \qquad (6)$$

where, $m_1$ was the mass of $Al_2In_{12}S_{21}$ sample, $m_2$ the mass of water in calorimeter, $m_3$ the mass of calorimeter; $t_1$ - the temperature of $Al_2In_{12}S_{21}$ sample, $t_2$ - the temperature of water and calorimeter before the mass $m_1$ was put in the water, and $\tau$ was a mean temperature when mass $m_1$ was put in the water and when the temperature of masses $m_1$, $m_2$ and $m_3$ were the same; $c_1$, $c_2$ and $c_3$ were specific heats of $Al_2In_{12}S_{21}$

$$c_1 = (0{,}36 \pm 0{,}04)\ J/gK \tag{7}$$

Debye temperature

The data of melting point were used for determining Debye temperature of $Al_2In_{12}S_{21}$ by using Lindenman's relation[6]:

$$T_D = B\ T_{MP}^{1/2}\ A^{-5/6}\quad {}_{o}^{1/3} \tag{8}$$

where, B was empiric constant (mean value 120), $T_{MP}$ was melting point in Kelvin's degrees (1353 $\mp$ 15), A was mean atomic weight (60.174) and $_{o}$ was the density of $Al_2In_{12}S_{21}$ (4.32 g/cm$^3$). Debye temperature calculated aproximatevly by (8) was

$$T_D = 238\ K \tag{9}$$

By using the Einstein's relation[7]

$$C_V = 3R\,\frac{e^{T_D/T}\,(T_D/T)^2}{(e^{T_D/T} - 1)^2} \tag{10}$$

where, R is the gas constant, $T_D$ Debye temperature, and T room temperature, we can calculate the specific heat of $Al_2In_{12}S_{21}$ in the following way

$$C_V = 0{,}39\ J/gK \tag{11}$$

This value is in good agreement with the specific heat value (7) which we obtained before.

Coefficient of linear thermal expansion

The measurements of linear thermal expansion coefficient were made by SADOMEL equipment. The results of those measurements were plotted in Fig. 1. It was easily recognized from the curves in that figure that thermal expansion of

$Al_2In_{12}S_{21}$ was linear with the dependence:

$$\alpha = (8.5 \mp 0.5) \times 10^{-6} \ (K^{-1}) \qquad (12)$$

Refractive index

The refractive index was measured by goniometer on a small monocrystal prism with the angle A being $20^o50' \mp 0^o20'$. The method of the smallest deviation ($\delta$) of light was used for obtaining refractive index

$$n = \frac{\sin \frac{A + \delta}{2}}{\sin \frac{A}{2}} \qquad (13)$$

In Fig. 2 are showh the results of the refractive index measurements in one part of the visible spectrum. It was seen that the refractive index monotonously changed from 2.715 at 5850 Å to 2.633 at 7250 Å.

Further investigations of physical properties of $Al_2In_{12}S_{21}$ are in progress.

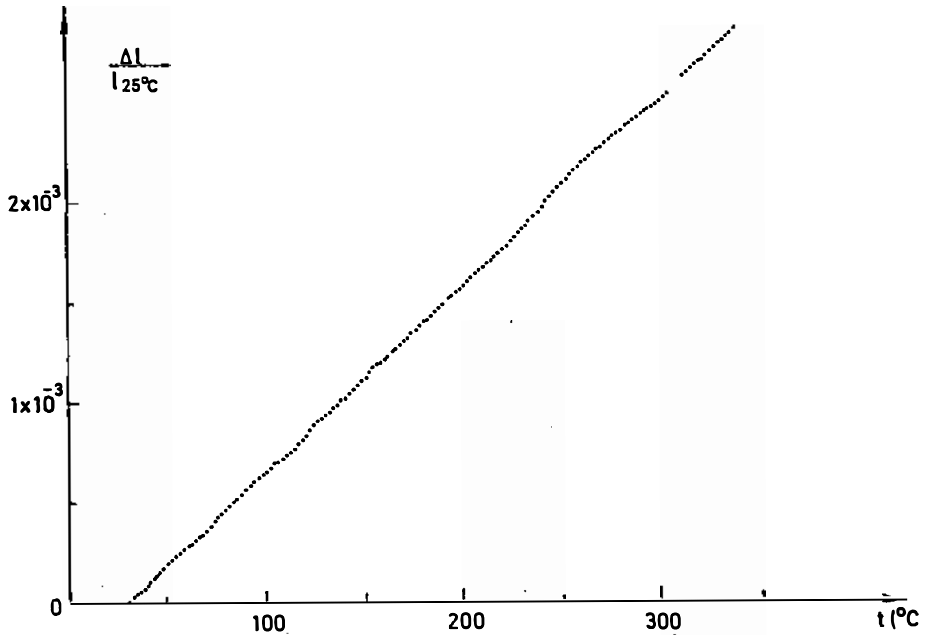


Fig.1. The dependence of $l/l_{25^oC}$ $Al_2In_{12}S_{21}$ versus temperature

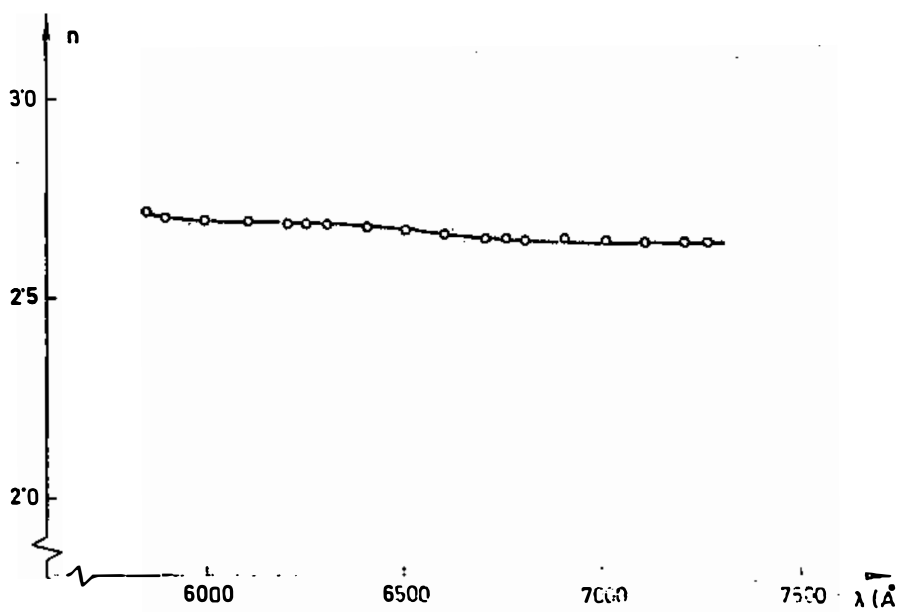


Fig.2. Refractive index of $Al_2In_{12}S_{21}$ in dependence of light wavelengths

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