DISPERSION PROPERTIES OF ZnS FILMS IN THE VISIBLE SPECTRUM

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Dispersion caracteristics of thermaly evaporated multilayer thin films, consisted of ZnS and cryolite (Na_3AlF_6), where investigated. The structure of multilayers where of the tupe[1]:

HL HL HL HL 64H LH LH LH LH,

where H is the layer of ZnS of the optical thicknes $\lambda/4$ and of high refractive index. L is the cryolite layer of the low refractive index. Described structure presents Fabry-Perot filter with ZnS spacer.

Filters were obtained by evaporation on the glass substrate in the vacuum of $5 \cdot 10^{-6}$ mmHg at the temperature of 25°C. Growing rate was 500 Å /min. Thickness of the films have been opticaly controled by measuring the change of intensity of transmited light.

Electro-optical apparatus consisted of an RCA 7102 photomultiplier and an PAR lock-in amplifier. Registration of the signal have been performed by using dual-channel recorder HP 7102B. Heating of the sample have been performed by using an IR source of 500 W.

Interpretation of results

Multilayer optical filter were treated as Fabry-Perot interferometers and dispersion curve shown on Fig.1. have been obtained.

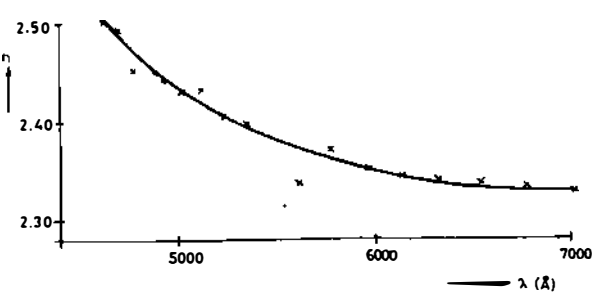

Fig. 1. Refractive index curve for ZnS thin film.

Dispersion have been determined from transmission maximum by using the relation[2]

$$n = \frac{\lambda_1 \lambda_2}{2d \Delta\lambda} ,$$

where d is the film thickness, λ_1 and λ_2 are wavelengths of successive maximum, $\Delta\lambda$ is the free spectral range. Very important correlation between our dispersion curve and those obtained by Hall and Ferguson[3] by measurements of reflection from ZnS monolayer. On the basis of experimental results, they found the refractive index by using the relation[3]:

$$n_f = \left[n_g (1+R_o)^{1/2} / (1-R_o)^{1/2} \right]^{1/2} ,$$

where n_f is the refraction index of film, n_g is the refraction index of substrate, R_o reflection at points satisfying

$$n_f d = m \lambda/4,$$

where m is an integer. The results are shown on Fig.2.

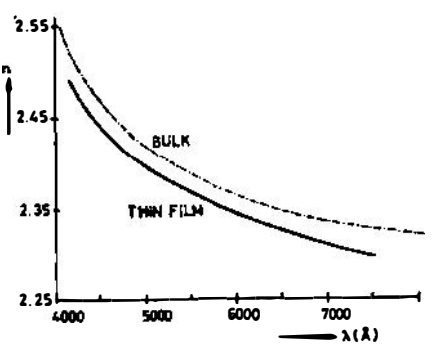

Fig.2. Index of refraction of ZnS.

Those results are comparable with dispersions obtained on the bulk of ZnS by De Vore[4], which can be seen on Fig.2.,too.

Comparison of the dispersion values obtained by Hall and

Ferguson, by De Vore, and our results, (Fig.1. and Fig.2.) appears that are qualitatively the same.

Successive thermal treatement of multilayer thin films show dependence of transmission intensity, on temperature. It has been found that the spectrum shifts towards larger wavelengths by increasing temperature, and to oposite under the cooling process, accompained with the significant loss of reproducibility. This means that the optical properties irreversibly change as the function of thermal treatment. Following this, a resonable approach in the analysis is structural investigation by means of electron microscopy. Preliminary results have shown grains of diameter of 200 Å, which changes under the process of thermal treatment. Further experimental effort is needed to educate this problem.

References

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3. J.F.Hall and W.F.C. Ferguson, J.Opt.Soc.Am. 45, 74 (1954).
4. J.R. Devore, J.Opt.Soc.Am. 41, 416 (1951).