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OPTICAL CHARACTERIZATION OF Cu_xS EVAPORATED FILMS FOR SOLAR CELLS.

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SUMMARY

Films of Cu_xS were being produced by evaporation techniques from stoichiometric amounts of copper and sulphur powder mixtured. We justify that optical reflection and transmission measurements, as already reported by (1), as well as the determination of refractive index are capable of providing determinations of the stoichiometry.

INTRODUCTION

The optimization of solar cells based on the Cu_2S/CdS heterojunction needs the obtention of thin films of cuprous sulfide close to the stoichiometry. It is, therefore, usefull to find non destruction (if possible) techniques that assure the control and evaluation of this parameter. We have used an optical method in the characterization of cuprous sulfide obtained by high vacuum evaporation (2). We have found that the evaluation of the direct and indirect gaps, as well as the refractive index are adequate variables to characterize the sample.

SAMPLE PREPARATION

The sample were produced by high vacuum evaporation (pressure: 10^{-6}Torr, aprox.) of syntetic chalcocite prepared in our laboratory or by evaporation of cuprous sulfide provided by K and K laboratoires, INC, Plainview N.Y. The parameters that we have controled are the thickness of films and the substrate temperature. It has been shown (2) the importance of this parameter in order to obtain a chalcocite rich sample.

High purity copper powder (Merck "pro analys" or Specpur Johnson and Mattei) is mixed with tridistilled sulfur powder in pellets and compressed at $2Kp/cm^2$ (3). After evacuation at 10^{-3}Torr in a quartz ampoule, the pellets are heat treated in the range of 450-600°C during 7-10 days and cooled for one day.

To identify the films composition we have employed the X-ray diffraction technique (4) and we have found the chalocite phase only when the film thickness is at least approximately 5000Å. For lowe thickness phases more rich in sulfur have been detected.

OPTICAL REELECTION AND TRANSMISSION

The theoretical relations have been already described (5,6,7). The measurements have been carried out on thin sulfide films on glass substrate using a Cary 17D spectrophotometer. For the reflectance measurements, an attachment built in the laboratory has been used; it consists of two aluminiezed plane mirrors and can be used at near normal reflection. The spectral reflectance of the mirrors has been measured and the observed data have been corrected with these values. The values found for the indirect and direct gaps (table I) have been calculated in the absorption coefficient vs. energy graph. Fig. 1 shows the absorption coefficient as a function of the wavelenth.

CONCLUSIONS

It is demostrated that one can obtaine, the chalcocite phase by evaporation in film of thickness higher than 5000A, aproximately. The compound characterization could be made by transmittance/reflecttance measurements. For chalcocite we obtain values of the indirect and direct energy gaps of 1.18 and 1.98eV, respectively.

The averaged refractive index is 3.4. From the measurements of samples having a different stoichiometric ratio we can assure that chalcocite (Cu_2S) presents the higher value of the indirect gap. on the contrary the direct transition gap of this phase is the lower.

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Table I

Samples preparation conditions and results in evaporated cuprous sulfide. p is the chamber presure and Ts the temperature of the substrate.

Sample	Conditions	Thickness	D. gap	I. gap	$\bar{n}$
M-30(C.S.)	Flash Evap. Kαk	5500Å	1,90eV	1,23eV	2,6
P-13 (H.S.)	Chalc.Evap. $p=2.6\times10^{-5}$ T $T_s = 160°C$	6500	1,98	1,18	3,4
P-13(C.S.)	Id	6500	2,06	1,18	3,8
P-14	Chalc.Evap. $p=1.10^{-5}$ $T_s=150°C$	1000	2,30	1,18	4,0

FIGURE CAPTION

Fig.1. Absorption coefficient vs. wavelenth óf evaporated films of cuprous sulfide. The thickness and preparation conditions of each sample are refered in table I.

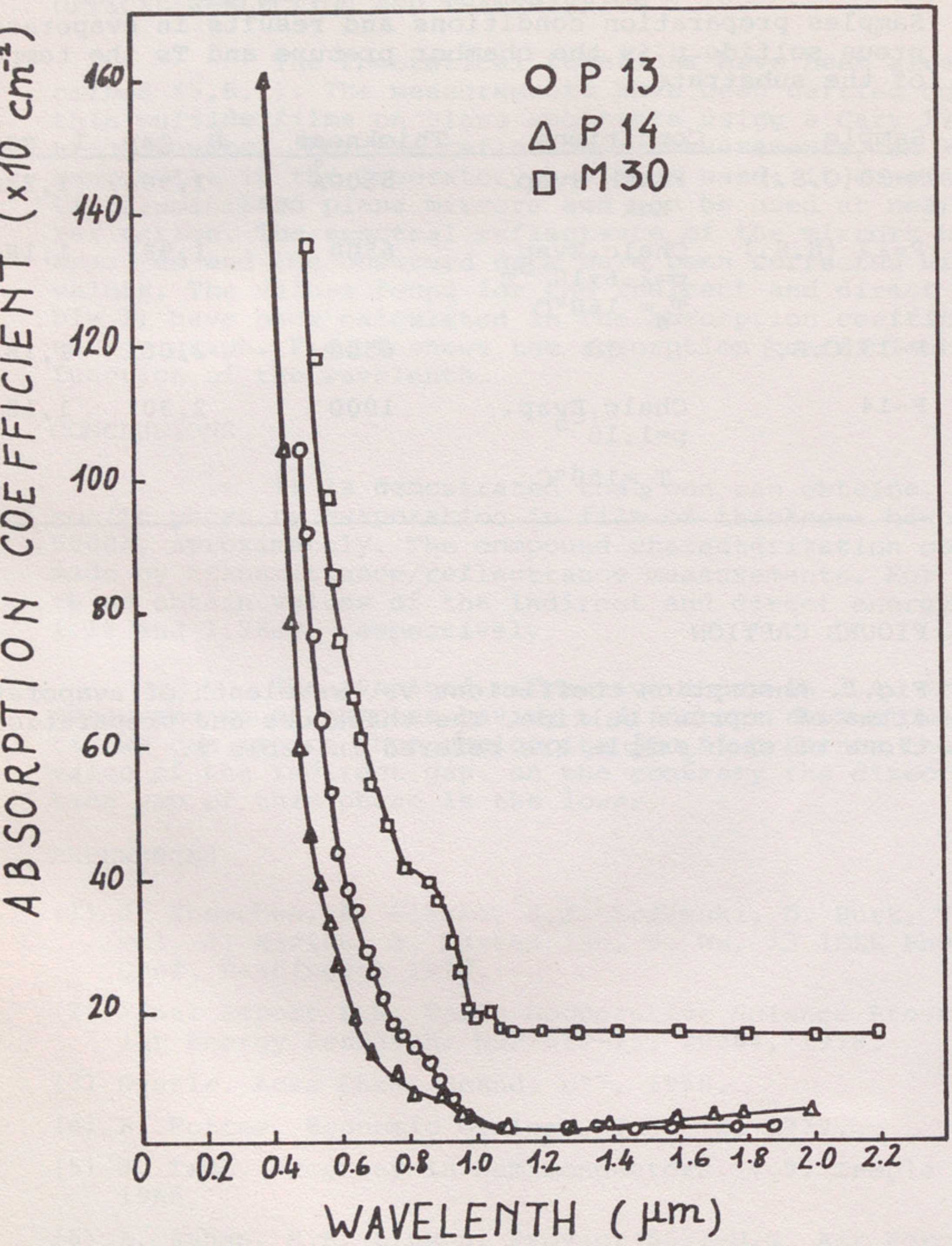
ABSORPTION COEFFICIENT (x10^{-3} cm^{-1})
160
140
120
100
80
60
40
20
○ P 13
△ P 14
□ M 30
0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2
WAVELENTH (μm)

Fig. 1