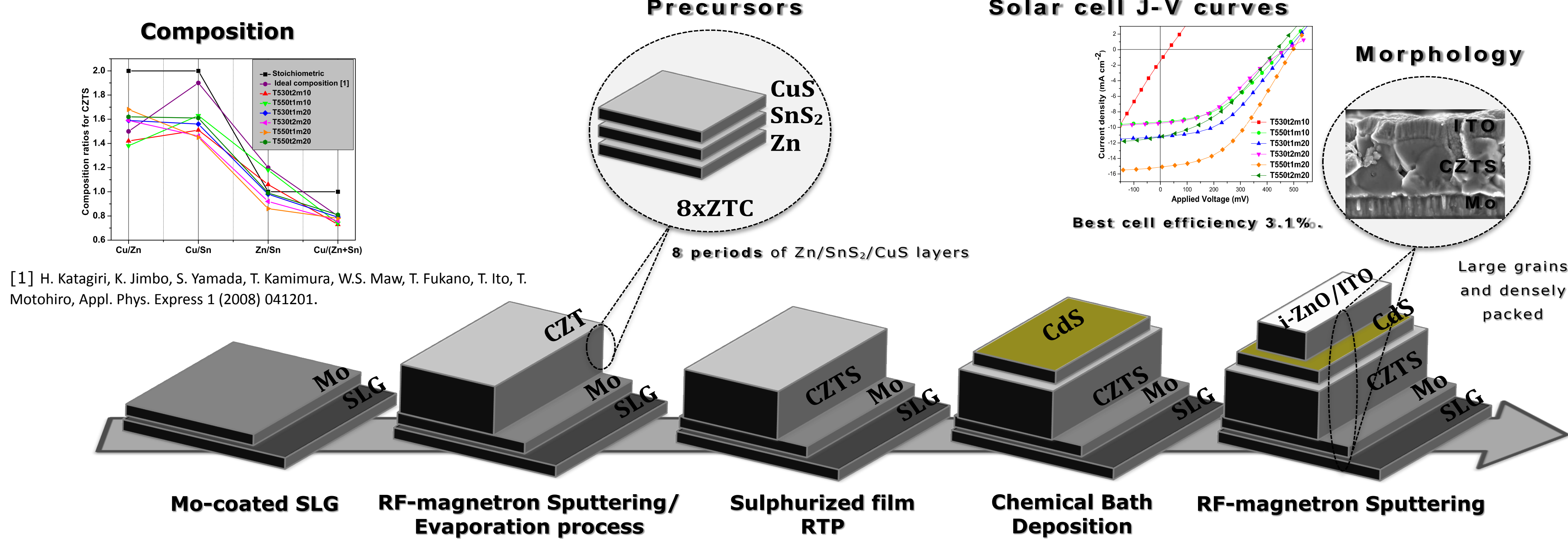


Effect of the sulphurization conditions on the properties of $\text{Cu}_2\text{ZnSnS}_4$ thin films and solar cell performance

Solar cell: **SLG/Mo/CZTS/CdS/i-ZnO/ITO**



[1] H. Katagiri, K. Jimbo, S. Yamada, T. Kamimura, W.S. Maw, T. Fukano, T. Ito, T. Motohiro, Appl. Phys. Express 1 (2008) 041201.



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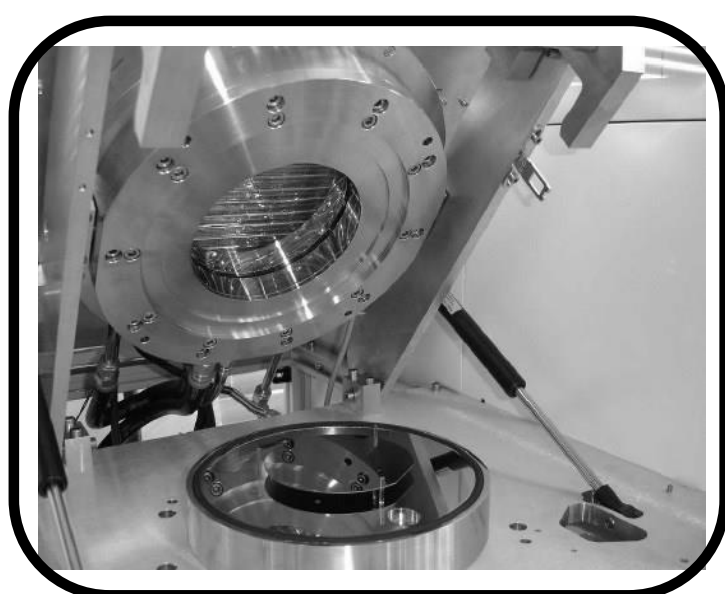
Supervisor: Prof. A.F. da Cunha

Objectives

We have studied the effect of several sulphurization parameters on the properties of $\text{Cu}_2\text{ZnSnS}_4$ thin films obtained through rapid thermal processing (RTP) of multi-period precursors with 8 periods of $\text{Zn/SnS}_2/\text{CuS}$ where Zn was thermally evaporated while SnS_2 and CuS were RF-magnetron sputtered. In this study we varied the heating rate, the time at maximum temperature, the maximum temperature and the amount of evaporated sulphur. The samples were characterized through scanning electron microscopy, energy dispersive spectroscopy, Raman scattering spectroscopy, X-ray diffraction, photoluminescence and I-V measurements.

Methods and techniques

Rapid Thermal Processing Furnace



The sulphurization was performed in the RTP furnace at an overall pressure of 1 atm consisting of partial pressure of 95% N_2 +5% H_2 and sulphur vapour resulting from the evaporation of elemental sulphur pieces placed near the sample under treatment. This process was carried out with the samples inside a graphite susceptor covered with a quartz lid and illuminated from the top.

Results

- These studies reveal that the samples sulphurized at higher temperature, shorter times and higher amount of evaporated sulphur exhibited larger grain sizes;
- The structural analysis based on Raman scattering and XRD did not reveal clear differences between the CZTS films;
- The cell results hint toward the detrimental effect of long sulphurization times and the positive effect of higher sulphur vapour pressure and higher sulphurization temperature;
- Photoluminescence spectroscopy studies showed an asymmetric broad band which occurs in the range of 1.0-1.4 eV.

The highest cell efficiency obtained in this study was 3.1%.

Sample	V_{oc} (mV)	J_{sc} (mAcm^{-2})	FF (%)	Efficiency (%)
T530t2m10	29.4	1.4	22.3	0.0
T550t1m10	462.4	9.3	40.8	1.7
T530t1m20	476.9	11.2	42.4	2.3
T530t2m20	471.2	9.5	36.3	1.6
T550t1m20	496.7	15.1	42.5	3.1
T550t2m20	435.8	11.2	37.1	1.8

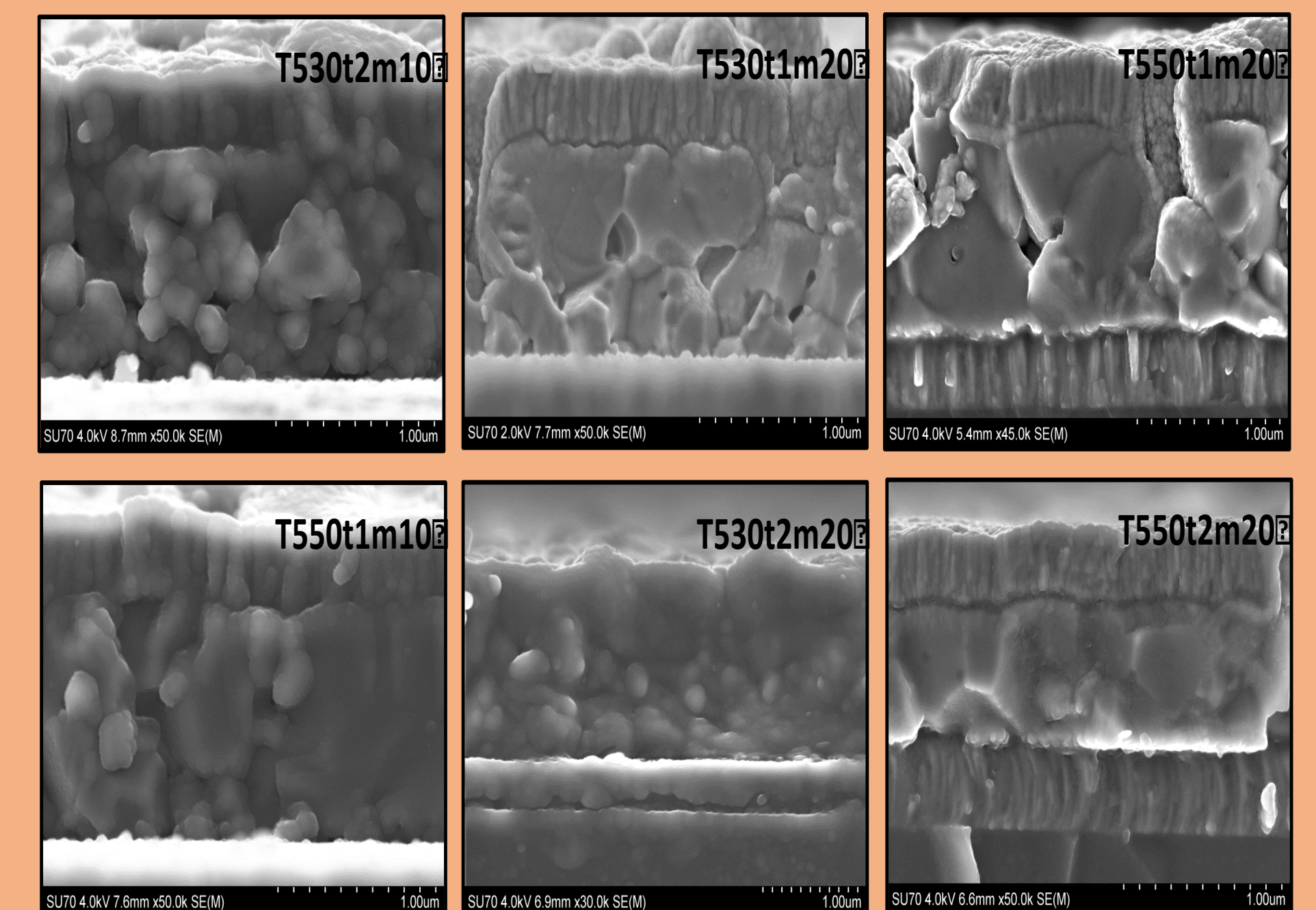
Publications

M.G.Sousa, A.F. da Cunha, P.A. Fernandes, J.P. Teixeira, R.A.Sousa and J.P.Leitão, Effect of rapid thermal processing conditions on the properties of $\text{Cu}_2\text{ZnSnS}_4$ thin films and solar cell performance, Sol. Energy Mater Sol. Cells 126 (2014) 101-106;

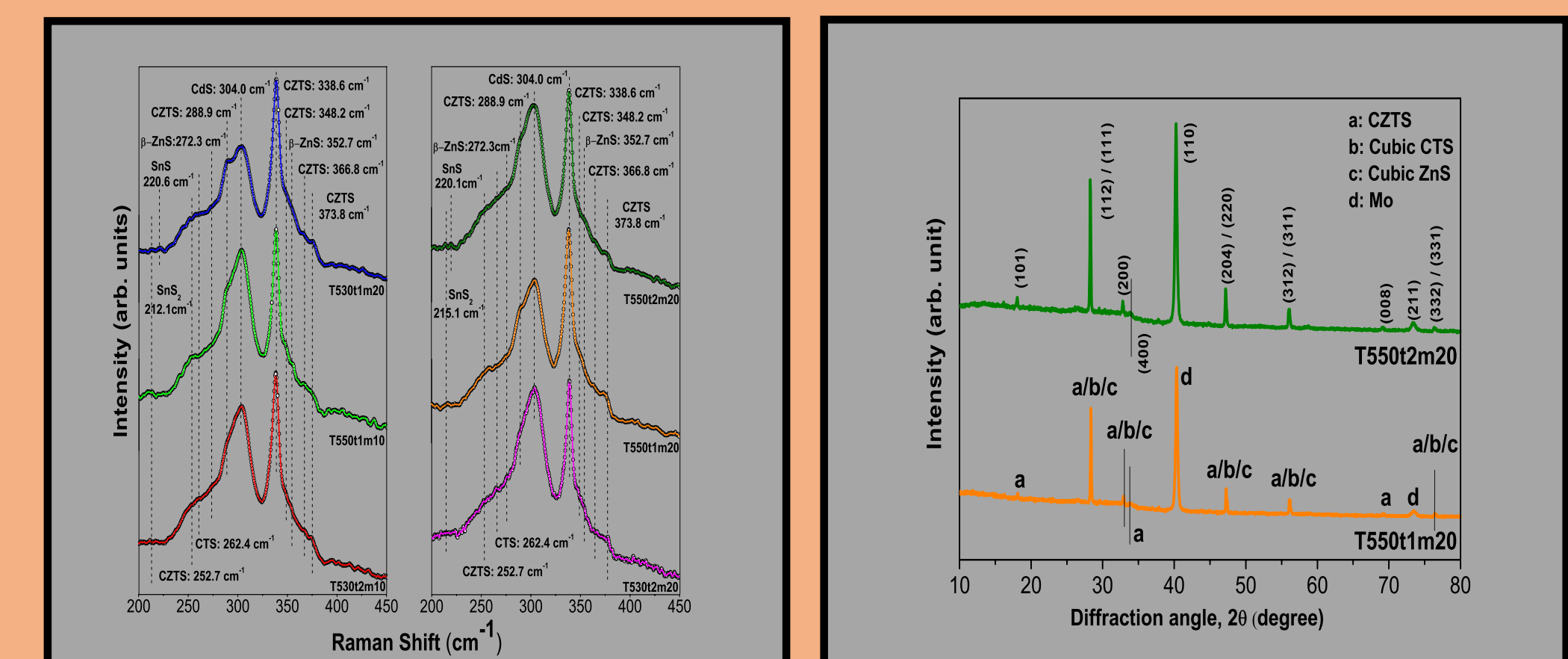
M.G.Sousa, A.F. da Cunha and P.A. Fernandes, Annealing of RF-magnetron sputtered SnS_2 precursors as a new route for single phase SnS thin films, J. Alloys Compd. 592 (2014) 80-85;

M.G.Sousa, A.F. da Cunha, P.M.P.Salomé, P.A.Fernandes, J.P. Teixeira and J.P.Leitão, $\text{Cu}_2\text{ZnSnS}_4$ absorber layers obtained through sulphurization of metallic precursors: Graphite box versus Sulphur Flux, Thin Solid Films 535 (2013) 27-30.

SEM/EDS Hitach SU-70 equipped with a Rontec EDS system operated at an acceleration voltage of 4.0 KV

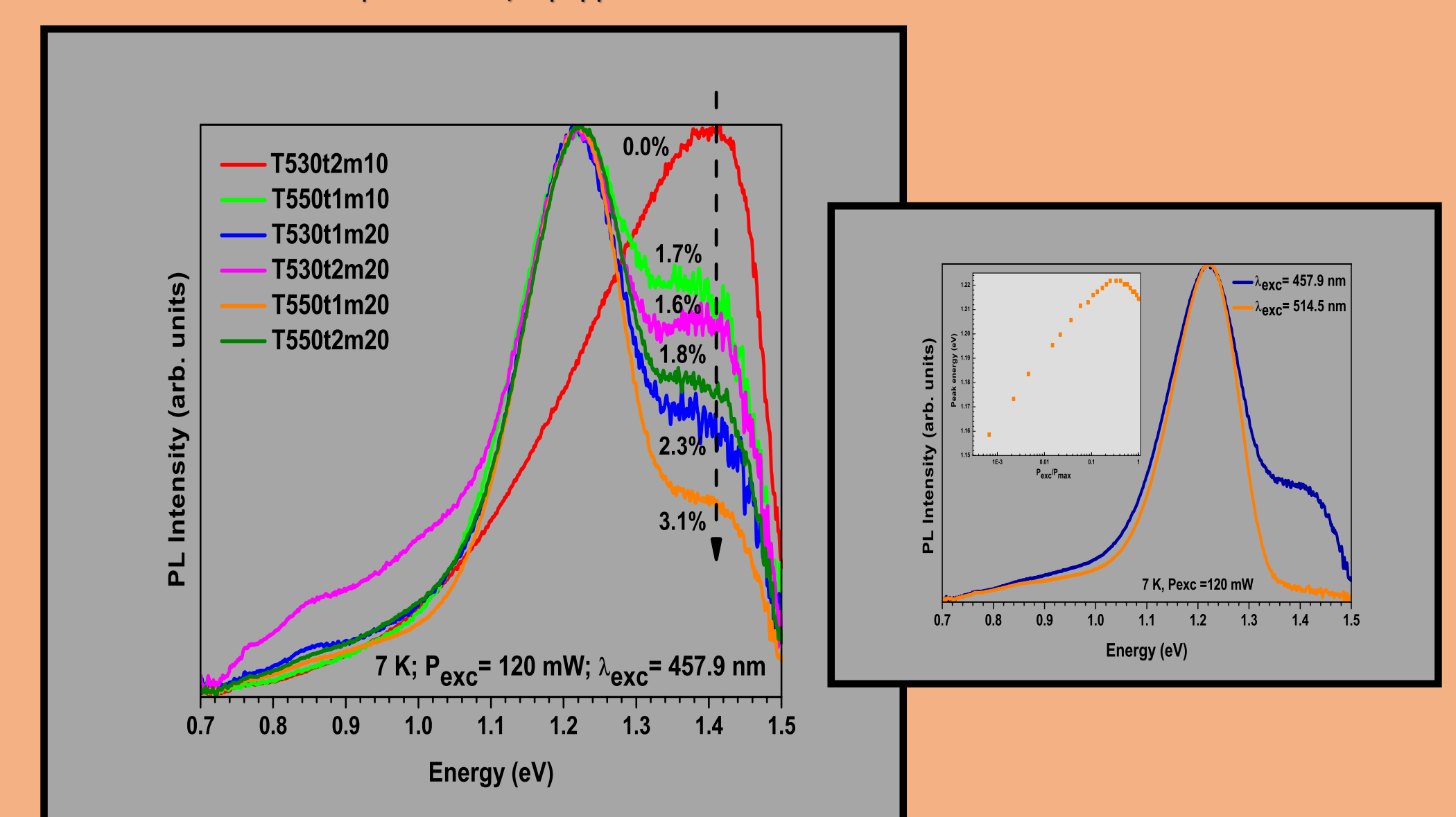


RAMAN LabRam Horiba, HR800 UV spectrometer, 532 nm excitation laser

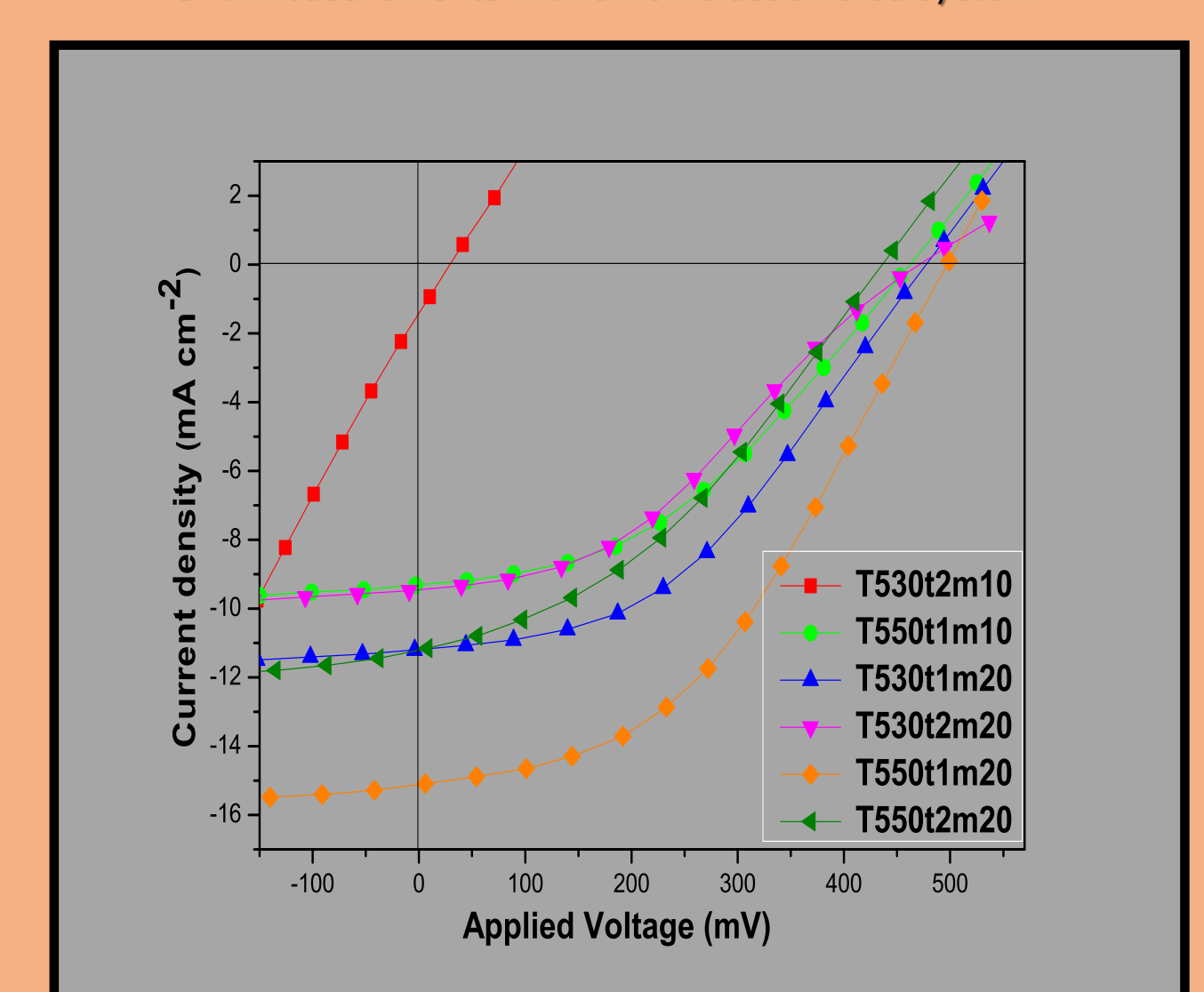


X'Pert MPD Philips PW 3710 system equipped with a CuK source XRD

PL Bruker IFS 66v FTIR spectrometer, equipped with a Ge diode detector



J-V measurements with a home assembled system



ACKNOWLEDGMENTS

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