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Research article

Rapid facile synthesis of Cu_2ZnSnS_4 films from melt reactions

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Supplementary

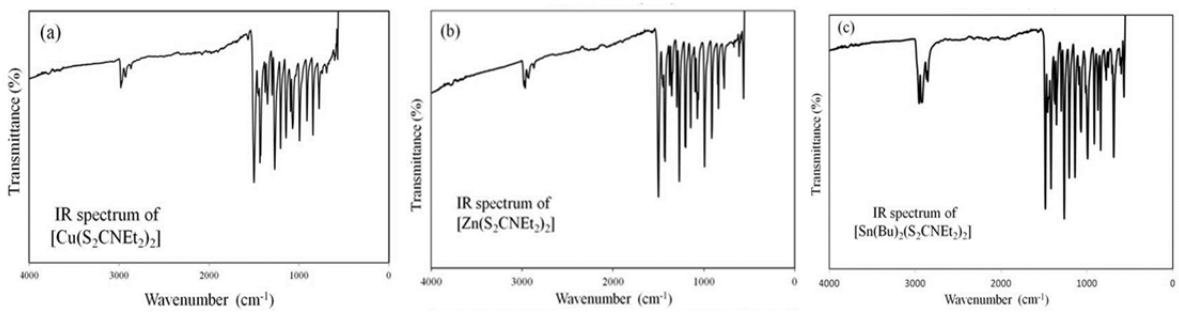

Figure S1. The FTIR spectra of the (a) $[Cu(S_2CNEt_2)_2]$, (b) $[Zn(S_2CNEt_2)_2]$ and (c) $[Sn(C_4H_9)_2(S_2CN(C_2H_5)_2)_2]$.

Table S1. TGA data analysis of dithiocarbamate complexes.

Complexes	M.W. $gmol^{-1}$	Metal sulfides	M.W. $gmol^{-1}$	% Calculated	% from TGA
$Cu(S_2CNEt_2)_2$	359.6	CuS	95.52	26.56	25.14
$Zn(S_2CNEt_2)_2$	361.46	ZnS	97.38	26.94	4.5
$Sn(C_4H_9)_2(S_2CN(C_2H_5)_2)_2$	528.9	SnS	150.68	28.49	9
		SnS_2	182.65	34.5	
		Sn_2S_3	333.34	63.02	

Table S2. Calculating texture coefficient (T_C) of CZTS films using equation: $T_{c(hkl)} = \frac{I_{(hkl)}/I_{o(hkl)}}{(1/N)[\sum_N I_{(hkl)}/I_{o(hkl)}]}$, where $T_{C(hkl)}$ is the texture coefficients of the (h k l) plane, I is the measured intensity, I_o is the ASTM standard intensity, N is the reflection number and ΣI(hkl) is the summation of the intensities for the (1 1 2), (2 2 0) and (3 1 2) peaks of the CZTS films [1,2].

Sample	Annealing temperature (°C)	(112)	(220)	(321)
a	375	1.479	0.122	1.402
b	400	1.489	0.252	1.261
c	425	1.423	0.263	1.316
d	450	1.536	0.293	1.173

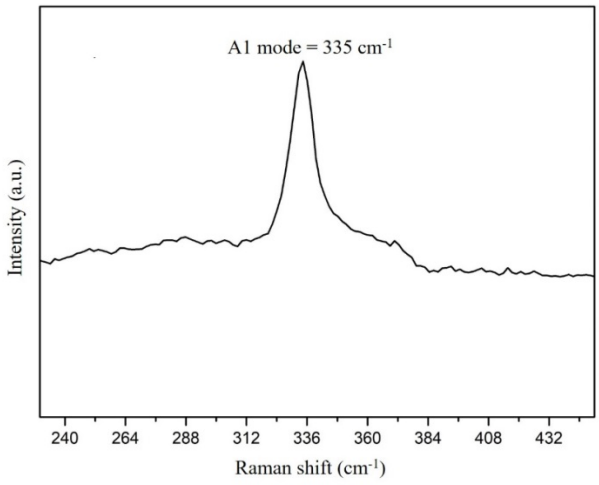

Figure S2. Raman spectrum of CZTS film heated in an N_2 atmosphere at 375 ^oC for 5 min.

Table S3. The experimental conditions and compositional of Cu_2ZnSnS_4 films deposited by the blade technique from diethyldithiocarbamate precursors in 5 min annealing time.

Sample	Annealing temperature (°C)	N_2 Gas flow rate (cm^3/min)	Average thickness (μm)	Cu(%)	Zn(%)	Sn(%)	S(%)	Cu/Zn+Sn	Zn/Sn	S/(Cu + Zn + Sn)
a	375	140	2.2	23.34	13.74	12.88	50.04	0.877	1.067	1.001
b	400	140	3.1	22.62	13.62	13.93	49.83	0.821	0.978	0.993
c	425	140	3.4	22.46	13.46	13.96	50.12	0.819	0.964	1.004
d	450	140	1.9	22.3	13.22	14.13	50.35	0.815	0.936	1.014

References

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2. Moholkar A, Shinde S, Babar A, et al. (2011) Synthesis and characterization of Cu_2ZnSnS_4 thin films grown by PLD: solar cells. *J Alloy Compd* 509: 7439–7446.

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