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THIN CIGS FILMS OBTAINED BY SPRAY PYROLYSIS

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Nanostructured materials stand apart from their bulk counterparts due to their fundamentally novel and improved properties. Metallic nanostructures are among the most extensively researched nanomaterials. Nanostructured thin films consisting of metal nanoparticles have found application in solar cells. Today, the solar cell market showcases a variety of technologies, with solar cells based on CIGS (Cu(In,Ga)(S,Se)2) attracting particular attention due to their high efficiency, durability, and the potential for economical fabrication methods.

In this research, we report the synthesis of thin films using spray pyrolysis. Indium and gallium sources were derived from InCl3 and GaCl3 chlorides, respectively.

METHODS AND CONDITIONS OF THE EXPERIMENT

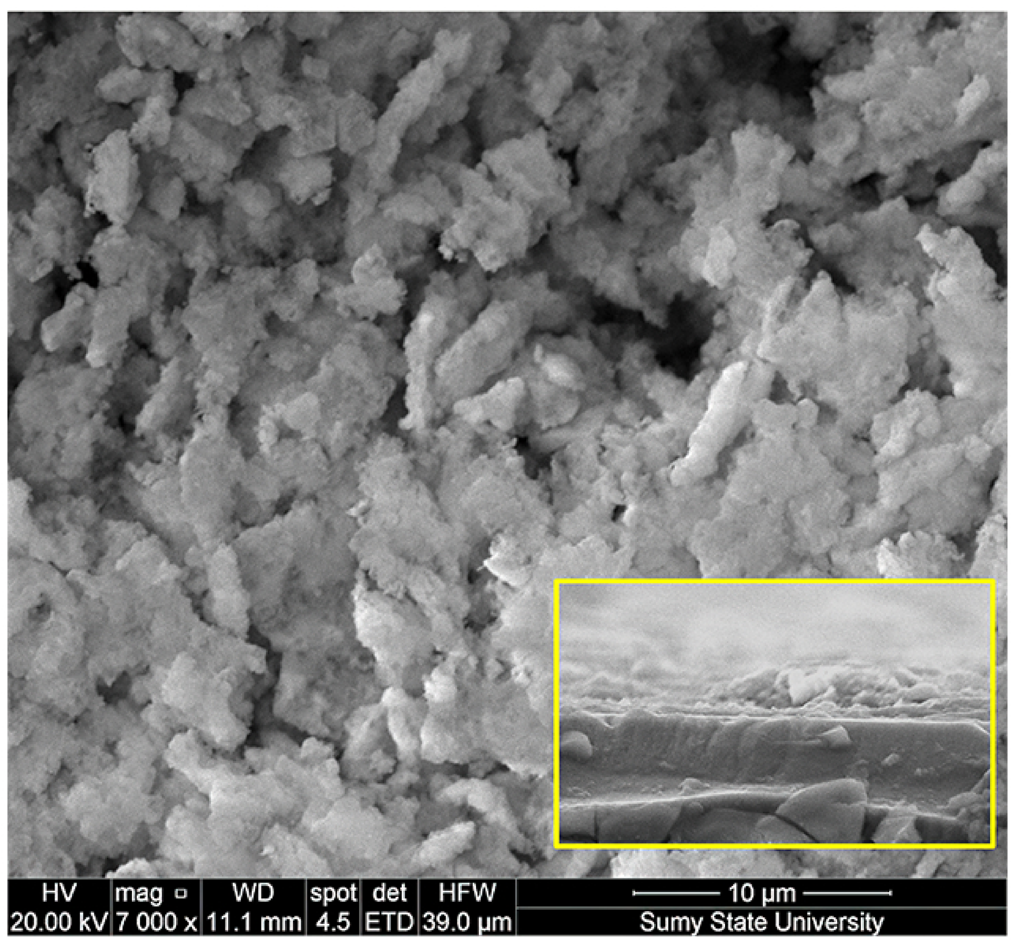
CuGaxIn1-xSe2 films were formed by the method of liquid phase pulverization (a spray-pyrolysis).

No.	Precursor	Characteristic
1	$CuCl_2$	anhydrous, 98%
2	$InCl_3$	anhydrous, 98%
3	$GaCl_3$	anhydrous, 99%
4	H_2SeO_3	anhydrous, 98%
5	$C_{18}H_{34}O_2$	anhydrous, 98%

TABLE 1. Precursors Used in the Experiment

Parameter	Value
Substrate Temperature	320 °C
The distance between a substrate and a nozzle	20 cm
Spraying Speed	3 ml/min
Spraying Time	10 min
Carrier Gas Pressure	3.5 MPa

TABLE 2. Experimental Conditions for Deposition of CuGaxIn1-xSe2 Films



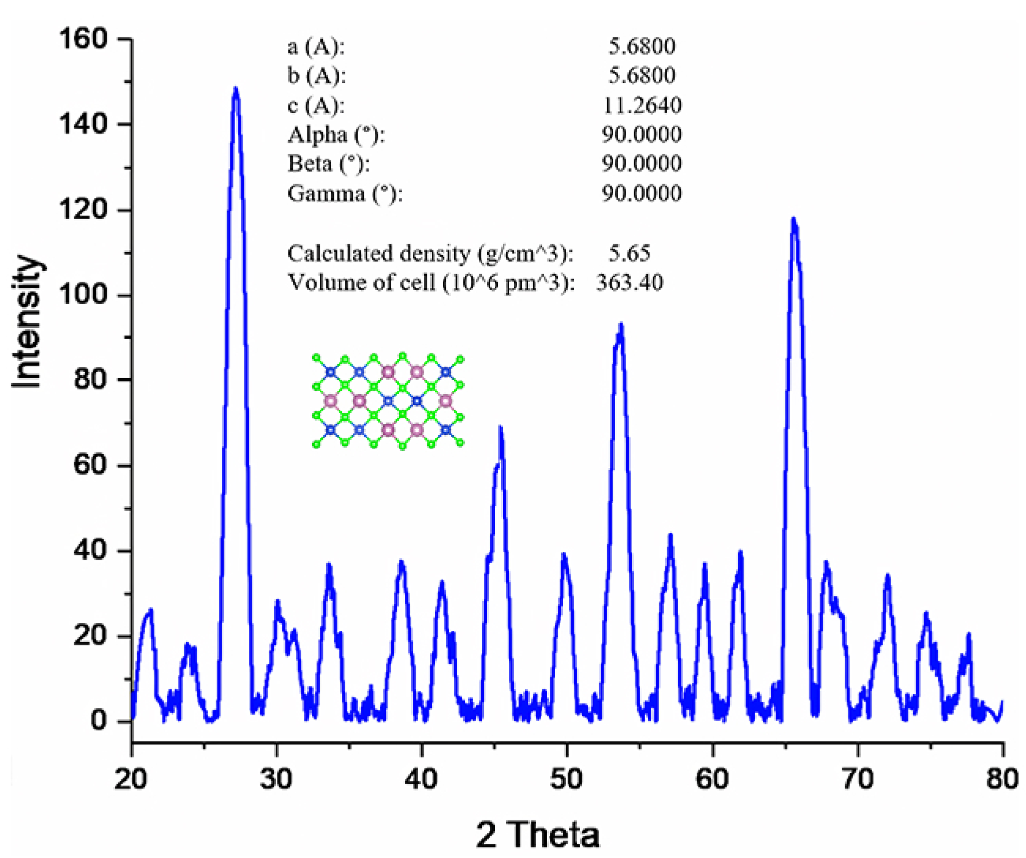
SEM analysis

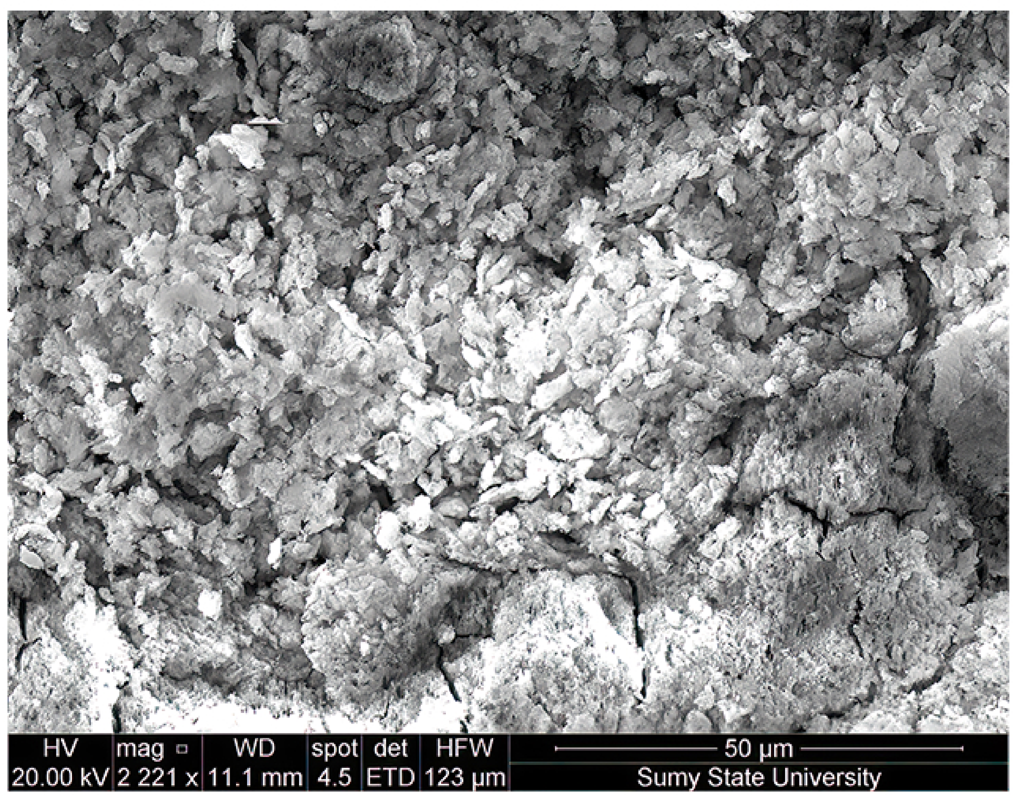
Spectrum	Cu (at%)	In (at%)	Ga (at%)	Se (at%)	Cu/(In+Ga)	Ga (In+Ga)
1	16,82	14,18	21,26	47,74	0,47	0,6

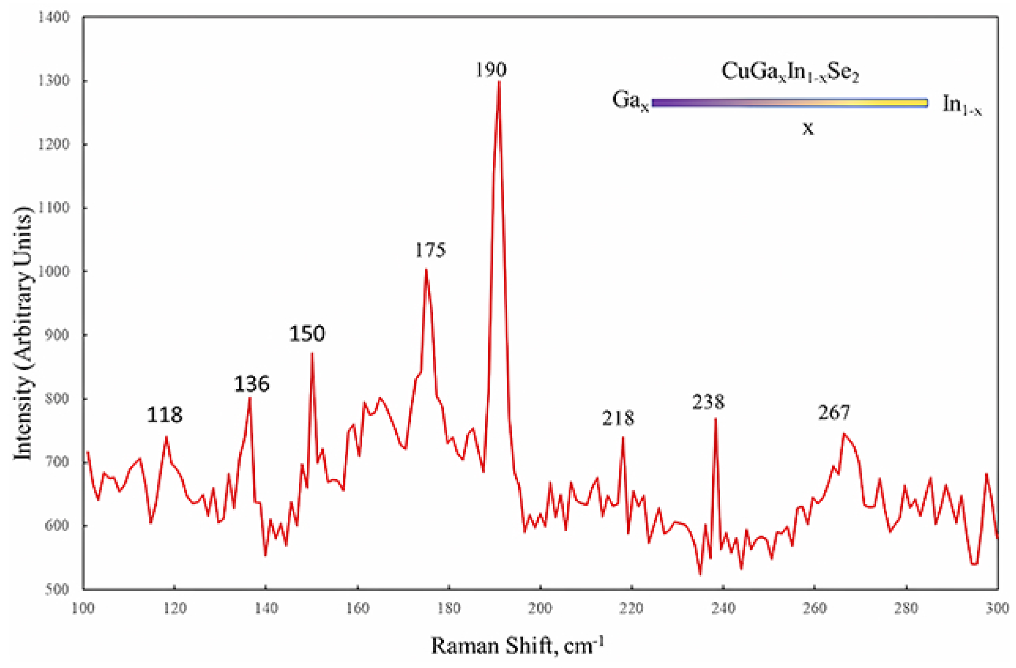
EDX analysis

No.	h	k	l	d, Å	2θ, deg
1	1	0	1	5,08	17,4
2	1	1	2	3,27	27,2
3	1	0	3	3,13	28,4
4	2	1	1	2,48	36,2
5	2	1	3	2,10	43,0
6	2	2	0	2,00	45,1
7	2	0	4	2,00	45,3
8	3	0	1	1,87	48,7
9	3	1	2	1,71	53,5
10	1	1	6	1,70	53,8
11	3	2	3	1,45	64,1
12	4	0	0	1,42	65,7
13	0	0	8	1,41	66,3
14	3	3	2	1,30	72,5
15	3	1	6	1,30	72,9

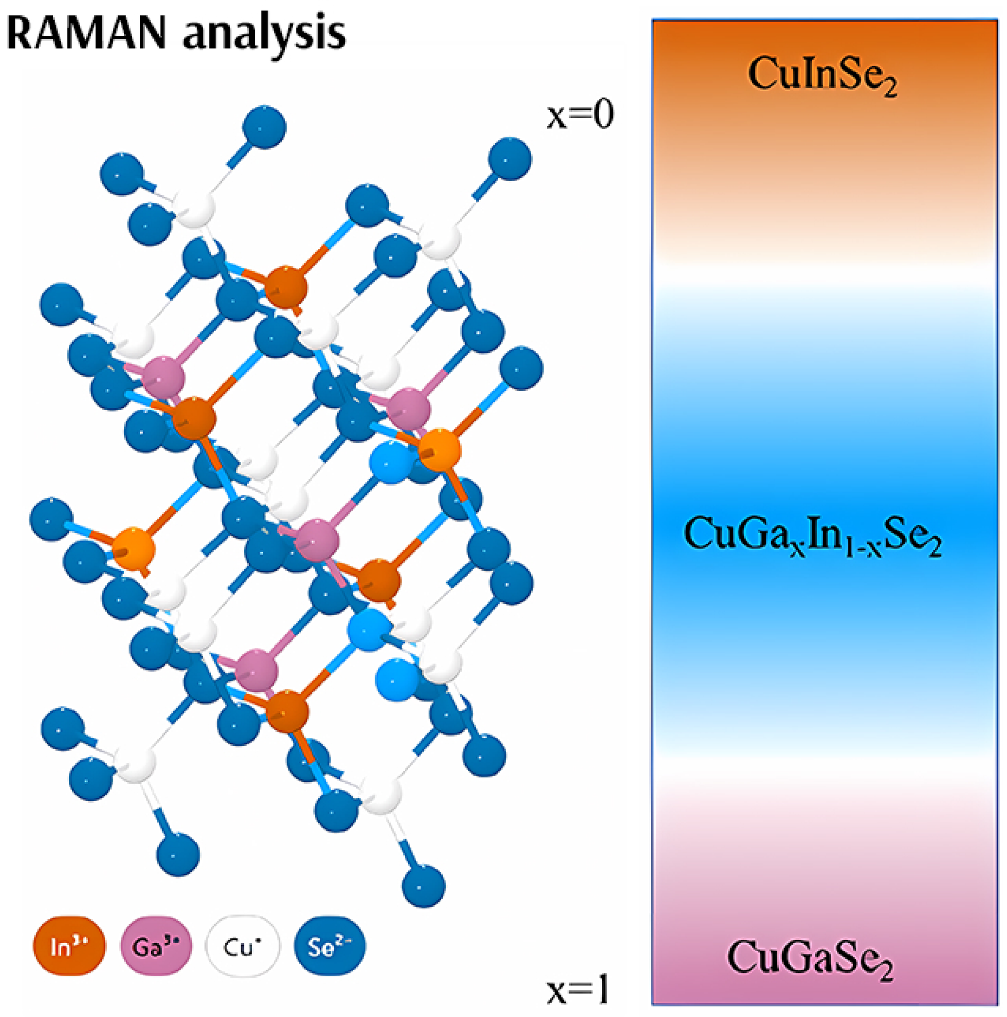
XRD analysis







RAMAN analysis



CONCLUSION

We have demonstrated a simple method of obtaining CuGaxIn1-xSe2 crystal layers.
As a result, a dense layer of CuGaxIn1-xSe2 consisting of porous crystallites was obtained.
EDX analysis showed that indium and gallium are in a 2:3 ratio. These data are significantly compliant with the results of XRD analysis.
A Raman scattering study showed the absence of peaks of the Cu2Se secondary phases.
This indicates the effectiveness of the proposed synthesis technique and the prospects for its use on an industrial scale.

ACKNOWLEDGEMENT

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