Supplemental Material

Effects of doped Sn content on the structure, morphology, optical and electrical properties of indium tin oxide thin films by microwave-assisted spray pyrolysis

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To verify the repeatability of the experimental results, two identical samples were conducted under the same deposition parameters. All the experimental data presented in this manuscript represent the average values of the two replicate tests.

The relative standard deviation (RSD) is a statistical relative indicator used to quantify the degree of data dispersion. This parameter reflects the extent to which individual data points deviate from the mean value, where a higher RSD value indicates a greater level of despersion. It is calculated by the following formula:

$$RSD = \frac{\sqrt{\dfrac{\sum_{i=1}^{n}(X_i - \overline{X})^2}{n-1}}}{\overline{X}} \times 100\%$$

(S-1)

Where $\overline{X}$ is the mean value of the measured samples, X_i is the individual measured value each sample, and n is the number of test replicates.

The RSD results from the ITO thin films with varying SnO_2 doping levels are shown in the Table S1.

Table S1 shows that the RSD values of surface roughness, film thickness and electrical resistivity are all within 15%, demonstrating good batch-to-batch repeatability of the prepared films fabricated under identical deposition conditions. The minor performance fluctuations (with RSD ≤ 15%) can be attributed to slight inhomongeneities of the quartz substrates, which is a common occurrence in the s deposition processes using pray pyrolysis.

Table S1 Relative standard deviation (RSD) of surface roughness, film thickness and electrical

resistivity for ITO films with different SnO_2 doping concentrations

Samples with different SnO_2 content (wt%)		0	5	10	15	20
Roughness	Average (nm)	22.9	17.1	5.27	9.78	12.1
	Deviation (nm)	± 1.8	± 1.6	± 0.45	± 0.93	± 1.05
	RSD (%)	11.1	13.2	12.1	13.4	12.3
Thickness	Average (nm)	590.8	486.95	404.7	310.3	295.65
	Deviation (nm)	± 40	± 35	± 30	± 27	± 25
	RSD (%)	9.6	10.2	10.5	12.3	12.0
Resistivity	Average ($\times 10^{-4}$ $\Omega \cdot cm$)	170.62	5.66	2.97	8.29	9.43
	Deviation ($\times 10^{-4}$ $\Omega \cdot cm$)	± 4.3	± 0.46	± 0.29	± 0.65	± 0.65
	RSD (%)	3.6	11.5	13.8	11.1	9.7