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Supplementary Information

Rapid laser-induced photochemical conversion of sol-gel precursors to In_2O_3 layers and their application in thin-film transistors

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For the precursor solution preparation, indium nitrate ($In(NO_3)_3$) was dissolved in 2-methoxyethanol (2-ME), in a concentration of 20 mg/ml, by stirring at room temperature for approximately 24 h. The solution was stored in ambient environment for 5 days before its use and stirred for 30 min prior to the spin-coating process.

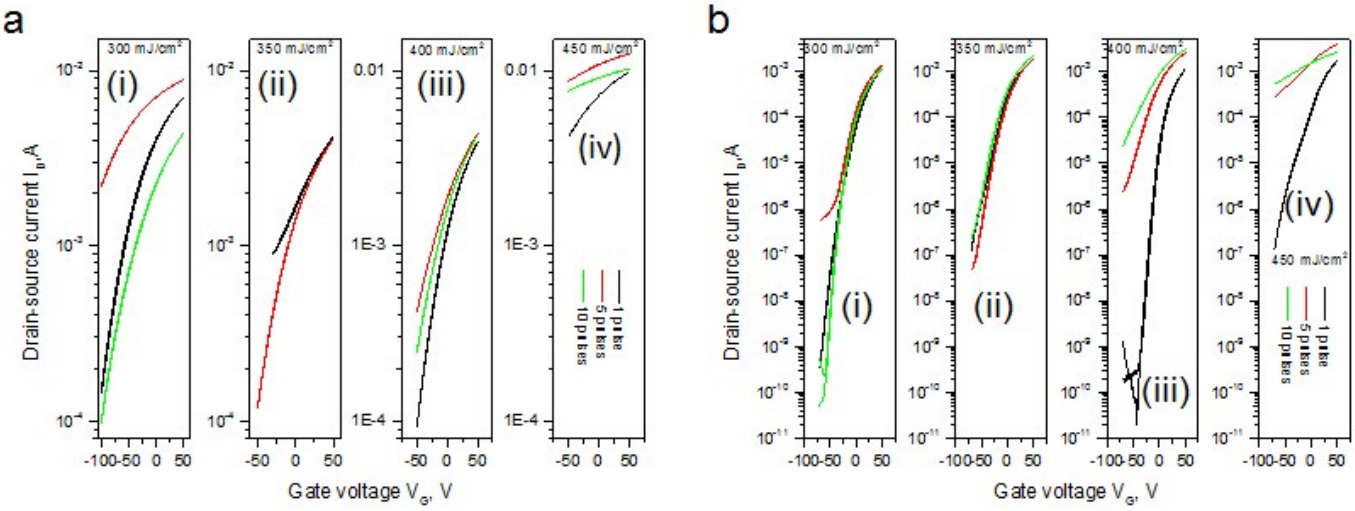

Figure S1. Transfer characteristics of the LA In_2O_3 TFT (a) before, and (b) after mild-thermal treatments. In both figures the results of LA with 1, 5 and 10 pulses at (i) 300, (ii) 350, (iii) 400, and (iv) 450 mJ/cm^2 are presented.

The transfer characteristics of all the laser annealed In_2O_3 TFTs before and after mild thermal treatment at 100 ^oC for 60 min are presented in Figure S1. The threshold voltage (V_{th}) and electron mobility presented in Figure 3 of the manuscript were calculated from these curves.

Figure S2 presents the X-ray Photoelectron wide spectra of the as-spun, the thermally annealed at 250 ^oC for 60 min, and the laser annealed (10 pulses at 300 mJ/cm^2) samples with and without mild thermal treatment. The atomic concentration of In, O_2, Si, and C as well as the atomic concentration ratio of [O]/[In] for each sample were calculated from these spectra (Table S1).

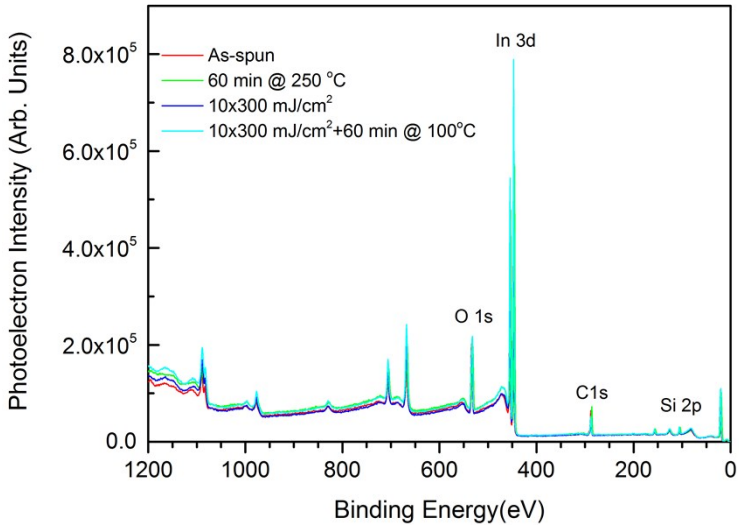

Figure S2. Indium Oxide thin film X-ray photoelectron wide spectra for as-spun, thermally annealed at 250 °C for 60 min, laser annealed with 10 pulses of 300 mJ/cm², and laser annealed with 10 pulses of 300 mJ/cm² followed by thermal annealing at 100 °C for 60 min.

Table S1. Results of XPS Surface Elemental Analysis of thermal and laser annealed Indium Oxide thin films

	[In] (% at)	**[O] (% at)**	**[Si] (% at)**	**[C] (% at)**	**[O]/[In]**
As-spun	21.11	47.28	4.58	27.09	2.24
Reference	21.77	45.48	5.54	27.21	2.09
10X300 mJ/cm²	24.59	49.24	6.15	20.01	2.00
10X300 mJ/cm²+TA	25.80	47.27	5.18	21.75	1.83

The high-resolution O *1s* spectra of every In_2O_3 film was deconvoluted to three peaks, attributed to In-O and In-OH bonds and O_2 adsorbates on the films' surface. The spectral position of these peaks are located at 529.5eV (In-O bonds in In_2O_3), 530.2 eV (O_2 adsorbates on films' surface), and 532.0 eV (water and In-OH bonds). The area percentage of these peaks in each type of In_2O_3 film are presented in Table S2.

Table S2. Area percentage of the deconvoluted peaks from the high-resolution O *1s* spectra.

	In-O	**In-OH**	**O Adsorbates**	**[In-O]/[In-OH]**
As-spun	29.6 %	53.6 %	16.7 %	0.55
Reference	31.5 %	48.1 %	20.4%	0.64
10X300 mJ/cm²	41.1 %	37.3 %	21.6 %	1.10
10X300 mJ/cm²+TA	43.8 %	34.4 %	21.8 %	1.27

In order to investigate the repeatability of the LA process, the total surface of a 2x2 cm^2 sample was laser annealed with raster scan (10 pulses at 300 mJ/cm^2). The chemical composition at three random areas on this sample was investigated by X-ray Photoelectron Spectroscopy. The X-ray Photoelectron wide spectra and the atomic concentration of In, O_2, Si, and C are presented in Figure S3 and Table S3, respectively. As it is shown from the data in Table S3, the [O]/[In] atomic concentration ratio in all areas is approximately the same and close to 2.00.

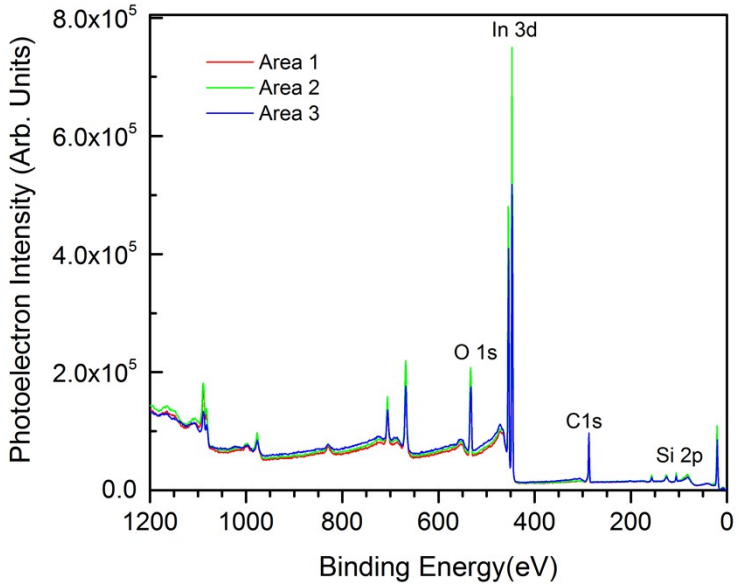

Figure S3. X-ray Photoelectron wide spectra of three different areas on a 2cm x 2cm In_2O_3 thin film, laser annealed via raster scan with 10 pulses of 300 mJ/cm^2.

Table S3. Results of XPS Surface Elemental Analysis of three different areas on a 2cm x 2cm In_2O_3 thin film, laser annealed via raster scan with 10 pulses of 300 mJ/cm^2..

	[In] (% at)	**[O] (% at)**	**[Si] (% at)**	**[C] (% at)**	**[O]/[In]**
Area 1	24.59	49.24	6.15	20.01	2.00
Area 2	24.72	49.52	5.66	20.10	2.00
Area 3	19.28	37.84	4.28	38.60	1.96

Furthermore, the high-resolution O *1s* peak spectra from the above three areas are presented in Figure S4.

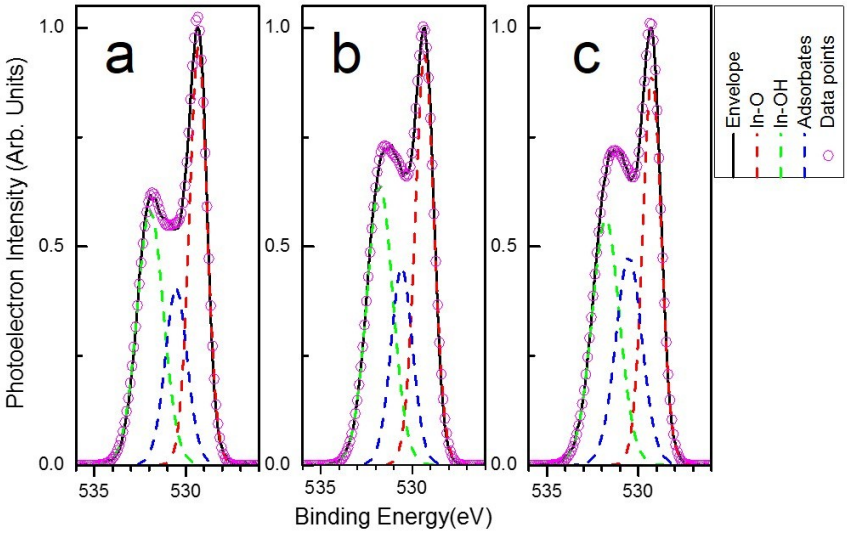

Figure S4. High-resolution O *1s* spectra from different areas 1 (a),2 (b) and 3 (c) of the raster scanned LA In_2O_3 thin film with 10 pulses of 300 mJ/cm^2. Together with the experimental data, plots include the deconvolution into In-O (red dashed line), In-OH (green dashed line), and O adsorbates (blue dashed line) peaks.

Table S4. Area percentage of the deconvoluted peaks of the XPS O *1s* high-resolution spectra from three random areas on a raster scanned LA In_2O_3 film with 10 pulses of 300 mJ/cm^2.

	In-O	**In-OH**	**O Adsorbates**	**[In-O]/[In-OH]**
Area 1	41.1%	37.3%	21.6%	1.10
Area 2	40.2%	37.7%	22.1%	1.07
Area 3	36.7%	35.0%	28.3%	1.03

Figure S5 presents the Tauc plots of as-spun and thermally annealed at 250 ^{o}C In_2O_3 thin films on top of UV-transparent quartz. From these diagrams, the optical band gap was calculated to be equal to 4.04, and 3.89 eV, for the as-spun and thermal annealed In_2O_3 films, respectively.

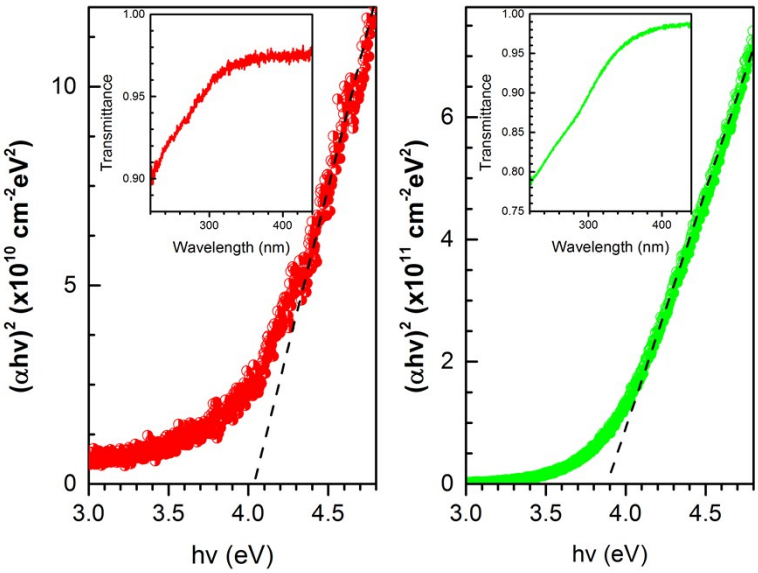

Figure S5. Tauc plots of as-spun and thermally annealed at 250 °C for 60 min In_2O_3 thin films. The extracted optical bandgaps are 4.04 and 3.89 eV, respectively.

Figure S6 presents the gate leakage current of In_2O_3 TFTs prepared by thermal annealing at high temperature (250 °C for 60 min) and with laser annealing followed by mild-thermal treatment (100 °C for 60 min). The measurement limit of the used equipment was 10^{-10} A.

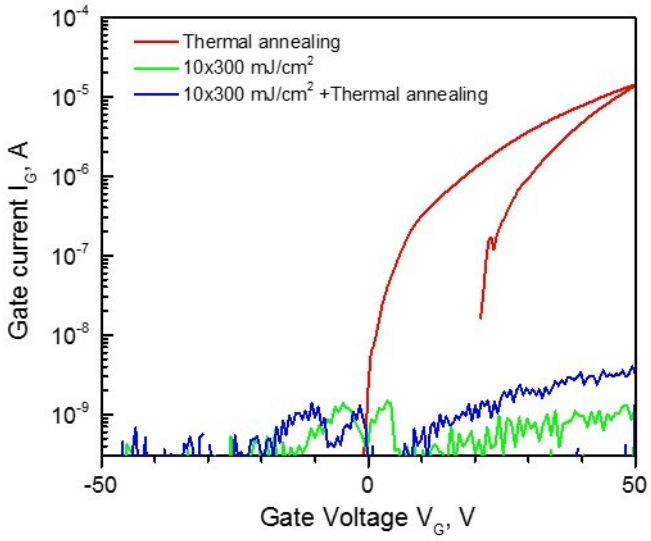

Figure S6. Gate Current vs. Gate Voltage of a thermally annealed TFT at 250 °C for 60 min compared with LA In_2O_3 TFTs with 10 pulses of 300 mJ/cm^2 with and without mild thermal treatment.