# Supporting Information

## Low-temperature, high-mobility, solution-processed metal oxide semiconductors fabricated with oxygen radical assisting perchlorate aqueous precursors

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Figure S1 shows the schematic of structure of the fabricated TFT device.

Figure S2 show the output characteristic curves of the $In_2O_3$-TFTs made by different precursors annealing at 250°C.

Figure S3 (a) to (c) show the X-ray photoelectron spectroscopy (XPS) O 1s scans of the $In_2O_3$ films prepared with $In(NO_3)_3$, $In(ClO_4)_3$, and $In(NO_3)_3$ + $In(ClO_4)_3$, respectively.

The mobility of TFTs with different precursors are listed in Table S1.

Figure S4 show the XPS (X-ray photoelectron spectroscopy) Cl 2p scans of the $In_2O_3$ films with mixture precursor under various annealing temperature.

Figure S5 shows the XRD (X-ray diffraction) scans of the $In_2O_3$ films annealed at different temperatures for 1 hour with the mixture precursor.

Figure S6 (a) to (e) show the AFM (Atomic Force Microscope) images of the $In_2O_3$ films annealed at different temperatures for 1 hour with the mixture precursor.

Figure S7 shows the transfer characteristic curves of the $In_2O_3$-TFT devices annealed at different temperatures for 1 hour with the mixture precursor.

Figure S8 (a) to (e) show the TG curves of $In_2O_3$ dry precursors from mixed precursors (nitrate and perchlorate) with different compositions. And Figure S9 (f) to (j) show the DSC curves of $In_2O_3$ dry precursors from mixed precursors (nitrate and perchlorate) with different compositions.

Figure S9 shows the transfer characteristic curves of $In_2O_3$-TFTs derived from mixed precursors (nitrate and perchlorate) with different compositions.

Figure S10 show the transfer and output characteristics of the ZnO-TFT device fabricated at the annealing temperature of 250°C by the same method.

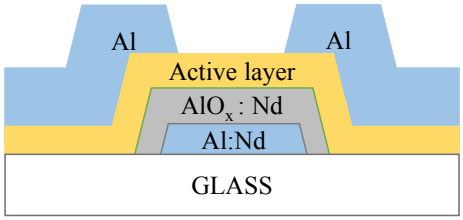


Figure S1. Schematic of structure of the fabricated TFT device.

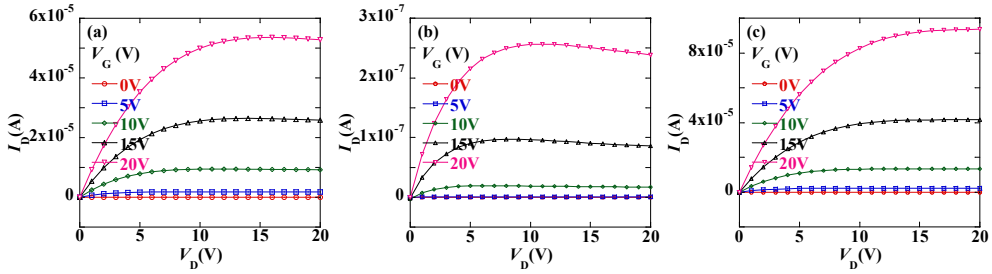


Figure S2. Output characteristic curves of the $In_2O_3$-TFTs made by (a) $In(NO_3)_3$ , (b) $In(ClO_4)_3$ , and (c) their 1:1 mixture precursors annealing at 250°C.

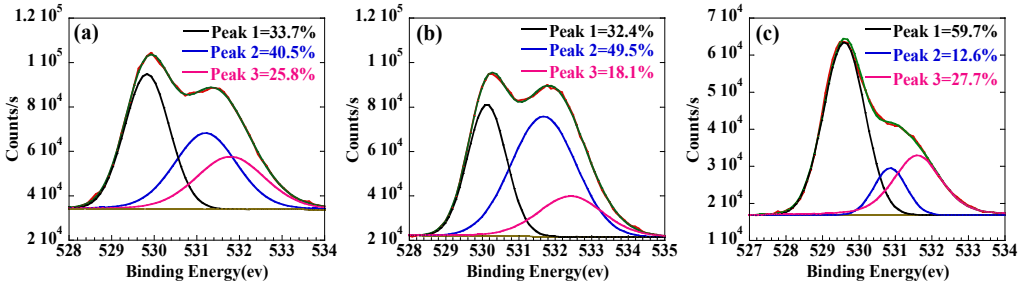


Figure S3. O 1s scans of $In_2O_3$ films prepared with (a) $In(NO_3)_3$, (b) $In(ClO_4)_3$, and (c) $In(NO_3)_3$ + $In(ClO_4)_3$ precursors annealed at 250 °C.

Table S1. Properties of $In_2O_3$-TFT made by different precursors annealing at 250 °C.

| Precursor | $\mu_{sat}$ ($cm^2 V^{-1}s^{-1}$) | Precursor | $\mu_{sat}$ ($cm^2 V^{-1}s^{-1}$) |
|---|---|---|---|
| $In(ClO_4)_3$ | 0.04 | $In(NO_3)_3$/ $In(ClO_4)_3$=1/1 | 14.5 |
| $In(NO_3)_3$ | 4.6 | $In(ClO_4)_3$/ $InCl_3$=1/1 | 0.65 |
| $InCl_3$ | 4.6 | $In(NO_3)_3$/ $InCl_3$=1/1 | 3.7 |

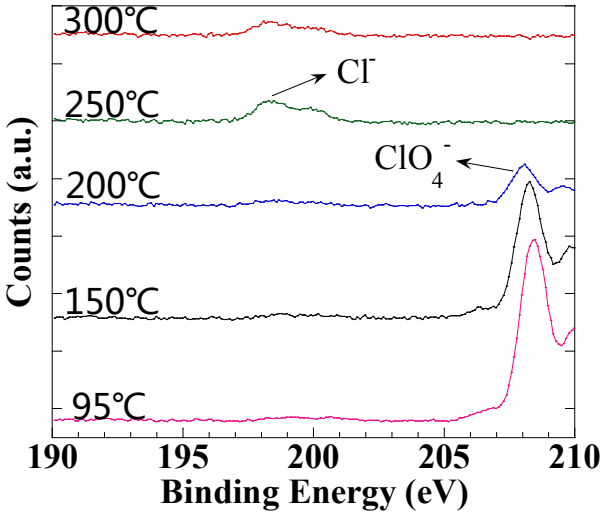


Figure S4. X-ray photoelectron spectroscopy Cl 2p scans of $In_2O_3$ films prepared with 1:1 mixture precursors annealed at (a) 95 °C, (b) 150 °C, (c) 200 °C, (d) 250 °C, and (e) 300 °C.

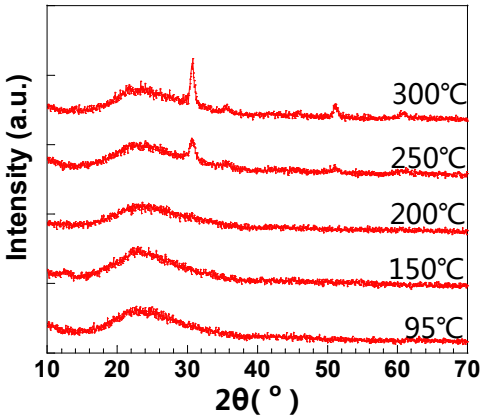


Figure S5. XRD pattern of the $In_2O_3$ film annealed at various temperatures for 1 hour with the 1:1 mixture precursor.

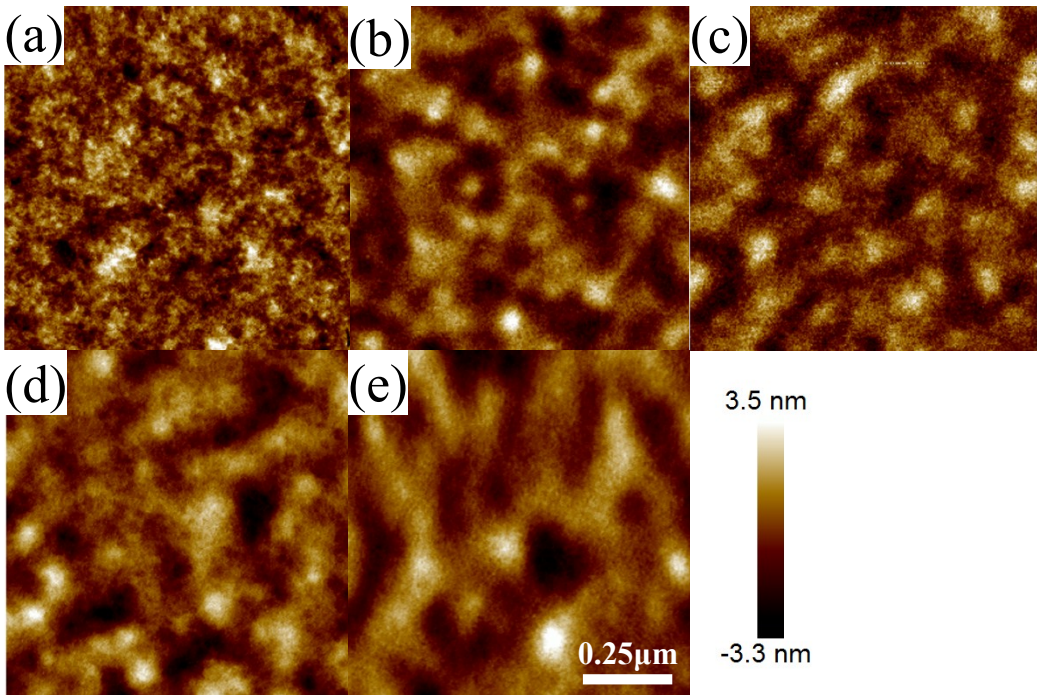


Figure S6. AFM images of the $In_2O_3$ film annealed at (a)95 °C, (b)150 °C, (c)200 °C, (d)250 °C, and (e)300 °C for 1 hour with the 1:1 mixture precursor.

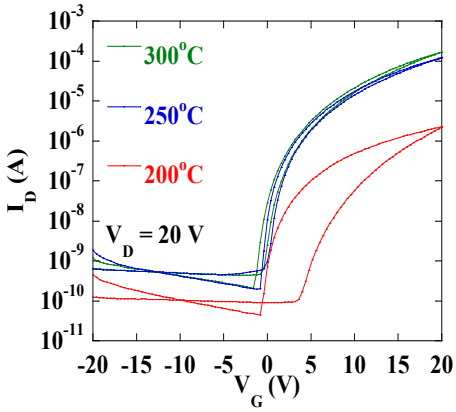


Figure S7. Transfer characteristic curves of the $In_2O_3$-TFT devices annealed at different temperatures for 1 hour with the 1:1 mixture precursor.

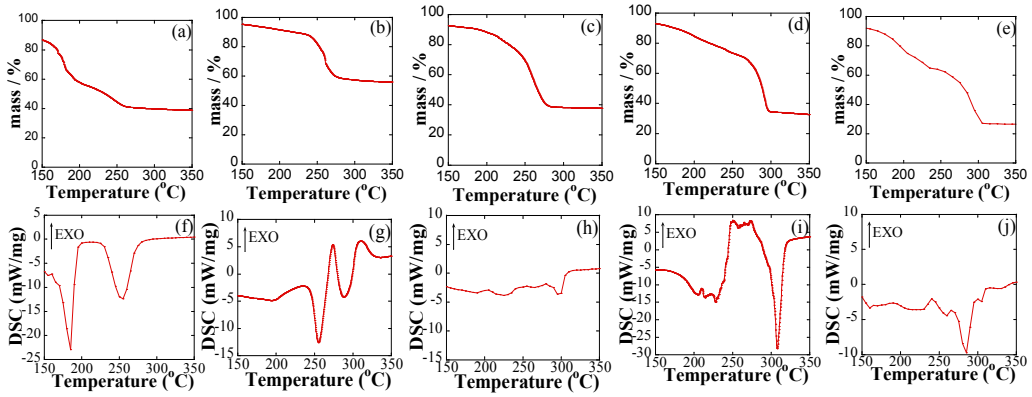


Figure S8. TG of the $In_2O_3$ dry precursors derived from mixed precursors with different compositions under the molar ratio of nitrate / perchlorate = (a) 1:0, (b)3:1, (c)1:1, (d)1:3, and (e)0:1; DSC of the $In_2O_3$ dry precursors derived from mixed precursors with different compositions under the molar ratio of nitrate / perchlorate = (f) 1:0, (g)3:1, (h)1:1, (i)1:3, and (j)0:1.

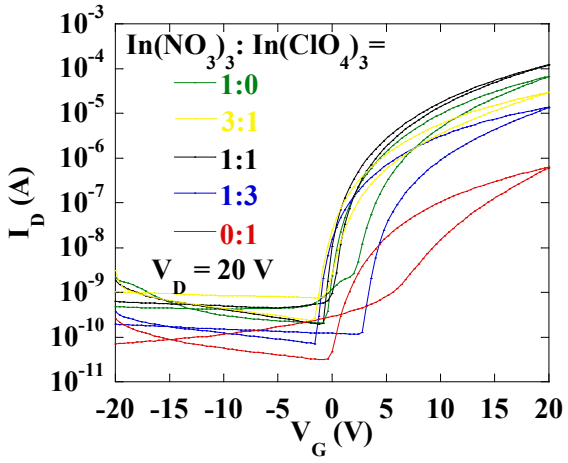


Figure S9.Transfer characteristic curves of $In_2O_3$-TFTs derived from mixed precursors (nitrate and perchlorate) with different compositions annealing at 250 °C for 1 hour.

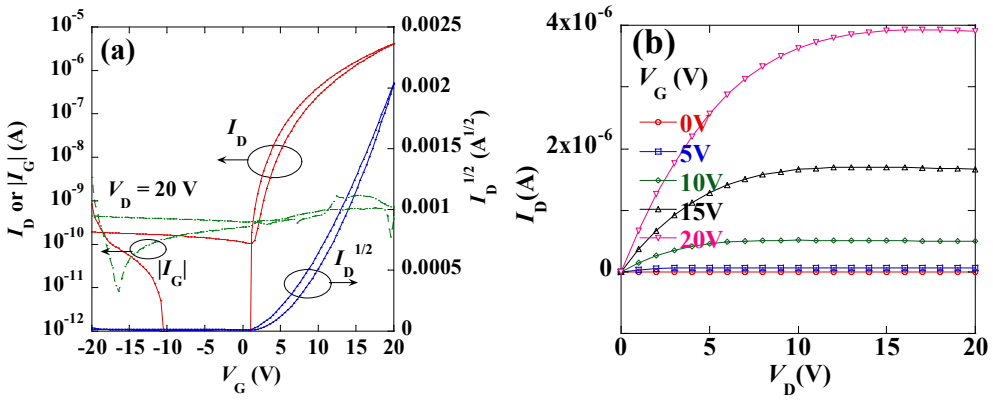


Figure S10. (a) Transfer and (b) output characteristics of the ZnO-TFT device fabricated at the annealing temperature of 250°C.