**Supplementary Material**

**Study of Wide Bandgap SnOx Thin Films Grown by a Reactive Magnetron Sputtering via a Two-Step Method**

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**Diagram S1:** Samples preparation, growth and annealing conditions

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Sample | Substrate Temp (°C) | O2/Ar% (Ar:O2 sccm) | Depos. Pressure (10-3 Torr) | Thickness (nm) |
| S0 | 100 | 0 (200:0) | 4.4 | 100 |
| S1 | 0.5 (200:1) | 4.5 | 242 |
| S2 | 1.5 (200:3) | 4.6 | 255 |
| S3 | 2.5 (200:5) | 4.7 | 277 |
| S4 | 4.5 (200:9) | 5 | 199 |
| S5 | 7.5 (200:15) | 5.1 | 153 |
| E0 | 250 | 0 (200:0) | 4.4 | 143 |
| E1 | 0.5 (200:1) | 4.5 | 170 |
| E2 | 1.5 (200:3) | 4.6 | 149 |
| E3 | 2.5 (200:5) | 4.7 | 181 |
| E4 | 4.5 (200:9) | 4.9 | 108 |
| E5 | 7.5 (200:15) | 5.1 | 163 |

**Table S1:** Summary of the RF sputtering conditions and thickness of samples.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **O2/Ar ratio (%)** | **Crystallite Size (Å)** | | | | | |
| **Deposition Temperature (**°**C)** | | | | | |
| **100** | **250** | **100** | **250** | **100** | **250** |
| As deposited | | Vacuum Annealing at 400 °C | | Air Annealing at 400 °C | |
| **0** | \* | \* | \* | \* | 116 | 109 |
| **0.5** | \* | \* | \* | \* | 51 | 54 |
| **1.5** | \* | 56 | \* | 61 | 56 | 52 |
| **2.5** | \* | 54 | \* | 56 | 62 | 53 |
| **4.5** | \* | 45 | \* | 56 | 61 | 55 |
| **7.5** | \* | \* | \* | 56 | 57 | 55 |

**Table S2:** Crystallite size for SnOx sample using Scherrer equation for peak (110).

Map

Description automatically generated

**Figure S1:** UV-Visible transmittance as a function of the wavelength for all the measured SnOx samples.

Diagram, histogram

Description automatically generated

**Figure S2:** Tauc plots for all the measured SnOx samples showing the respective optical bandgaps.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **FoM Ref.** | **Material** | **Synthesis method** | **Doping** | **Eg (eV)** | **resistivity (Ohm.cm)** | **Sheet resistivity (Ohm/)** | **T%** | **FoM (10-3 Ohm-1)** |
| 1(1) | SnO2:Sb | Spray Pyrolysis | Yes | 3.82 | 5.8 x 10-5 | 0.61 | 88 | 47.2 |
| 2(2) | SnO2:Ba | Spray Pyrolysis | Yes | 3.85 | 6.95 × 10-4 | 69 (calculated) | 90 | 5.02 |
| 3(3) | SnO2:Sb | Spray Pyrolysis | Yes | 3.77 | 1.16 x 10-3 | 141 (calculated) | 85 | 1.39 |
| 4(4) | SnO2:Sb | Spray Pyrolysis | Yes | 3.81 | 7.89 x 10-4 | 24.9 | 89 | 12.5 |
| 5(5) | SnO2:Ta | Spray Pyrolysis | Yes | 3.77 | 4.55 x 10-4 | 25.1 | 81 | 6.15 |
| 6(6) | SnO2 | Spin Coating | No | 3.92 | 2.63 x 10-3 | 63 | 85 | 3.3 |
| 7(7) | SnO2:Ti | Sol Gel Spin Coating | Yes | 3.83 | 1.77 x 10-3 | 42.3 | 83 | 3.66 |
| 8(8) | SnO2:F | Spray Pyrolysis | Yes | NA | 8 x 10-4 | 40 | 89 | 2 |
| 9(9) | SnO2:F | Sol Gel Dip Coating | Yes | 3.91 | 7 x 10-4 | 14.5 | 90 | 24.3 |
| 10(10) | SnO2:F | Chemical Vapour Deposition / Pulsed Laser Annealed | Yes | NA | NA | 8.8 | 85 | 23.2 |
| 11(11) | SnO2:Te | Pulsed Laser Deposition | Yes | 3.5 | 0.2 | 2.22 x 104 | 87 | 0.012 |
| 12(12) | SnO2:La | Spray Pyrolysis | Yes | 3.86 | NA | 2.1 | 80 | 20 |
| 13(13) | SnO2:Li | Spray Pyrolysis | Yes | 3.89 | 1.19 | 2.05 | 80 | 0.02 |
| 14(14) | SnO2:F | Atmospheric Pressure Chemical Vapour Deposition | Yes | 4.15 | 8.4 x 10-4 | 10.5 | 84 | 16.7 |
| 15(15) | SnO2:F | Spray Pyrolysis | Yes | NA | 4 x 10-4 | 3.71 | 87 | 61.8 |
| 16(16) | SnO2:Ta | Spray Pyrolysis | Yes | 4.01 | 4.36 x 10-4 | 17.96 | 85 | 47.3 |
| 17(17) | SnO2:F | Spray Pyrolysis | Yes | NA | 1.14 x 10-3 (calculated) | 7.48 | 65 | 1.93 |
| 18(18) | SnO2:GO | Spray Pyrolysis | Yes | 3.69 | NA | 26 | 77 | 2.83 |
| 19(19) | SnO2:Gd | Spray Pyrolysis | Yes | 3.63 | 1.02 x 10-3 | 27 | 86 | 8.2 |
| 20(20) | SnO2 | Sputtering | No | 3.86 | 4.45 x 10-3 | 287 (calculated) | 84 | 0.57 |
| 21(21) | SnO2:Sb | Spray Pyrolysis | Yes | NA | 1.22 x 10-3 | 15.42 | 71 | 2.11 |
| 22(22) | SnO2:As | Chemical Vapour Deposition | Yes | 3.87 | 1.5 x 10-4 | 15 | 85 | 13.1 |
| 23(23) | SnO2:Sb | Spray Pyrolysis | Yes | 3.88 | 8 x 10-4 (calculated) | 40 | 88 | 6.9 |
| 24(23) | SnO2:F | Spray Pyrolysis | Yes | 4.07 | 3.8 x 10-4 (calculated) | 20 | 93 | 24.19 |
| Present Work | SnO2 | Sputtering | No | 4.4 | 7.2 x 10-2 | 4.8 x 104 | 87 | 0.05 |

**Table S3:** Summary of the FoM values and SnOx electrical and optical properties selected from relevant literature (1-23).

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