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Article

Preparation of Antimony Tin Oxide Thin Film Using Green Synthesized Nanoparticles by E-Beam Technique for NO_2 Gas Sensing

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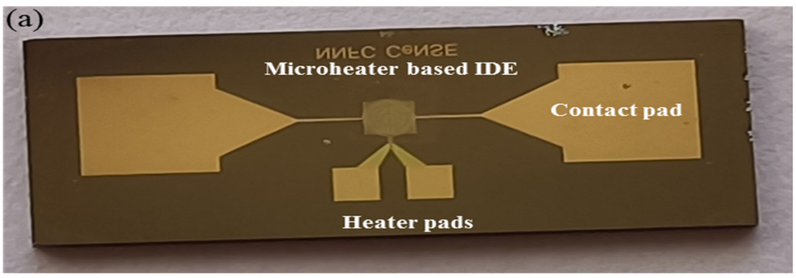
1. Materials and Methods

1.1. Preparation of ATO films using E-beam evaporation

In the present work, synthesized nanoparticles of ATO were used to prepare thin films. These nanoparticles were coated on silicon wafers and dies containing IDE substrates using the e-beam deposition method to perform various studies. A Si wafer doped with boron and polished on one side, measuring 525 microns in thickness, with an orientation of 100 and 10 Ωι cm of resistivity was utilized as the substrate to conduct investigations on the microstructural, morphological and elemental composition properties of films. Si wafers were cleaned by adapting RCA cleaning standard procedures. To perform the gas-sensing measurements, the films were coated on dies that had IDEs. The dies were fabricated by the CeNSE (Center for Nano Science and Engineering) at the IISc, Bangalore. For the fabrication of dies, techniques such as optical lithography, sputtering and the lift-off process were employed. The dies had a total length of 13.5 mm and a width of 3 mm, a gap between electrodes of 5μm, an electrode length of 1020 μm, 100 fingers, electrode pads of 3mm×3mm and an electrode-to-pad distance of 3.2 mm. Ti/Pt contacts were made using an interdigitated pattern in dies for electrical measurements. Isopropyl alcohol vapors were used to clean dies, followed by washing with deionized water, drying with nitrogen gas and ultrasonically agitating with acetone.

Figure.1(a) and Figure.1(b) display the photographs of the microheater and normal IDE. An appropriate mechanical mask (with a central aperture of 2 mm by 2.2 mm) were utilized to coat the ATO nanomaterial in the center of a 5-micrometer microheater-based IDE sensing area that measures 1 mm by 1.1 mm. The die and stainless steel-based mechanical mask are displayed in 1(c).



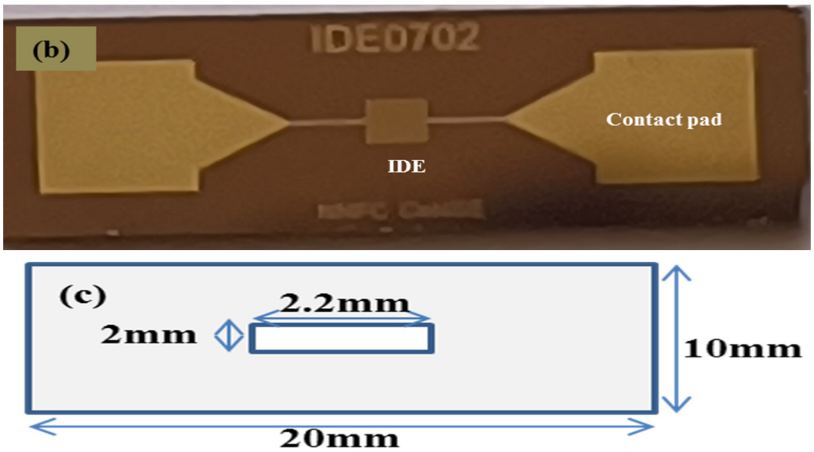


Figure S1. a) Photograph of microheater-based IDE, (b) photograph of normal IDE, and (c) dimensions of mechanical mask.

2. Results and discussions

The elemental compositional properties of the prepared ATO films are described in this section.

2.1. Elemental compositional studies

Every material's composition is determined to play an important role in determining its electrical characteristics. EDX was used for the elemental compositional analysis. The presence of oxygen, tin and antimony elements in the film are confirmed by the spectra displayed in Fig.2.

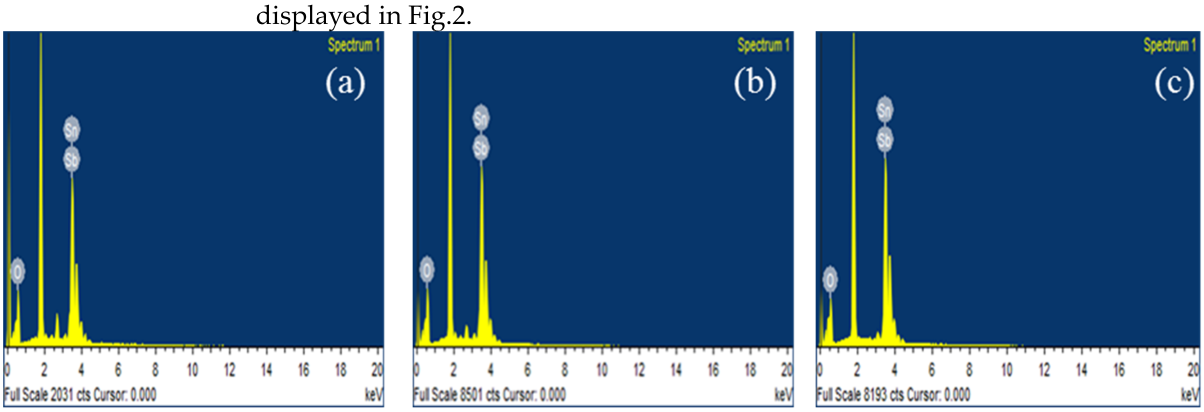


Figure S2. EDX spectrum of ATO film: (a) as-deposited, (b) annealed at 500°C, (c) annealed at 600°C.

The atomic and weight percentage of Sn increase while those of O decrease for 600°C for the 2wt% antimony, as shown in Table 1. Because of the structural reformation brought on by the annealing process, the results showed a good match with the SEM pictures, which show a defragmented distribution of the deposited films.

Table S1. Atomic and weight percentages of ATO films.

Element	As-deposited		500°C-Annealed		600°C-Annealed	
	Weight %	Atomic %	Weight %	Atomic %	Weight %	Atomic %
O	30.59	73.65	28.40	72.27	24.37	69.71
Sn	67.66	25.89	69.77	27.22	73.75	29.72
Sb	1.75	0.46	1.83	0.51	1.88	0.57