Nanostructured Semiconducting Metal Oxides for Highly Sensitive Gas Sensors

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ABSTRACT

Sensors for detecting and measuring gases are becoming increasingly important in various sectors including automotive, industry, healthcare and smart home. Gas sensors can help to achieve an increase in efficiency, reduction in cost, improvement of safety and security, and reduction of the burden on the environment. The market for gas sensors was valued at USD 1.82 billion in 2016 which is estimated to grow at a compound annual growth rate of 7.5% during 2017-2025. Among different technologies used for gas sensing, semiconducting metal oxides based solid state gas sensors show good promise because of their higher sensitivity, lower cost, ease of fabrication and maintenance, ability to be easily integrated with electronics and miniaturized etc. However, for metal oxide gas sensors to find wider applications, they need further improvement in their performance, particularly in terms of selectivity. Researchers are investigating the use of nanostructured oxides, mixed oxides, composite oxides, and their combinationin an effort to improve the performance of metal oxide gas sensors. The first part of this talk gives an overview of gas sensors. In the second part, our research work on the synthesis and gas sensing behaviour of one dimensional (1D) TiO_2 and ZnO/SnO_2 based nanostructures are described. TiO_2 nanowires and TiO_2-Al_2O_3 core-shell nanowires were prepared by thermal oxidation in an oxygen-deprived environment on Ti and Ti-6Al-4V (Ti64) alloy particles respectively. ZnO/SnO_2 based nanostructures were synthesized by carbon assisted thermal evaporation. Loading of these nanowires with Pd nanoparticles by chemical reduction was also carried out. The nanostructures were characterized by different microscopic, spectroscopic and diffraction techniques. To fabricate the sensor platform, prepared nanostructures were deposited onto interdigitated Au electrode printed on alumina substrate. Gas sensing performance of the fabricated sensors was then investigated in a tube furnace under controlled temperature and gaseous environment. The electrical resistance of the sensor was recorded continuously during the test. The 1D nanostructures were tested for their response to wide ranging gases e.g., H_2, CH_4, CH_3OH, C_2H_5OH,

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Day 1 Schedule

Date: 21-Jul-2023; Day: Friday

Time	Duration (min), Venue and Description					
8.15 to 9.00 45minutes	Registration of the Participants and Conference Kit Distribution				Auditorium Facilitators: Tech Staff Members of MPE dept, Mahmudul Firoz, TA, Student Volunteers	
9.00 to10.15 75minutes	5	Inauguration Session	Recitation from the Holy Quran		Venue: Room A (Auditorium)	
	5		Welcome introduction by Conference Chair			
	5		Speech by Dean, FET			
	5		IUT and MPE Dept Video			
	5		Speech by Guest of Honor [Mr. Mohammad Totonji, Executive Director, Dar Manar, KSA and Trustee of IIIT, USA			
	7		Speech by Pro VC			
	8		Speech by VC			
	10		Speech by Chief Guest [Prof. Dr. Abdul Jabbar Khan, Pro VC, BUET]			
	5		Vote of thanks by Conf. Hon. Secretary			
	5		Crest and Conference kit handover			
	5		Photo session			
10.15 to 10.20, 5 minutes, Tea Break						
10.20 to10.50 30minutes	Keynote 1: **Dr. Yongbo Li**, NWPU- Northwestern Polytechnical University, China			Room A (Auditorium)	Chair	**Prof. Dr. Nurul Absar Chowdhury**, *MPE, AUST*
					Facilitator	Ms. Sharmin Akter Urmee
10.50 to 11.20 30minutes	Keynote 2: **Prof. Dato' Dr. Mohammad Fauzan Bin Noordin**, Director, International Institute of Islamic Thought- IIIT, East and Southeast Asia				Chair	**Dr. M. Abdul Aziz**, *DG, BIIT*
					Facilitator	Ms. Sharmin Akter Urmee
11.20 to 11.50 30minutes	Keynote 3: **Prof. Dr. A. S. M. A. Haseeb**, Department of Nanomaterials and Ceramic Engineering, BUET				Chair	**Prof. Dr. Shamsuddin Ahmed**, *MPE, IUT*
					Facilitator	Ms. Sharmin Akter Urmee
11.50 to 12.20 30minutes	Keynote 4: **Ms. Abdullah Nahid Niger**, DMD-Deputy Managing Director, Ananda Shipyard				Chair	**Dr. Seri Rahayu Binti Kamat**, UTeM
12.40 to 14.30, Lunch and Prayer Break						

H_2S, CO, O_2 and NO_2. The ratio of the resistance of the material in N_2 to that in the target gas was used to denote the response of the sensors. Results reveal that nanowires of TiO_2 grow on pure Ti particles, while TiO_2-Al_2O_3 core-shell nanowires grow on Ti64 alloy particles during controlled thermal oxidation. It is proposed that stress plays a significant role in the development of 1-D nanowires on both Ti and Ti64 alloy substrates. TiO_2-Al_2O_3 core-shell nanowires show high sensitivity and selectivity towards CH_3OH and C_2H_5OH. This behaviour was attributed to the catalytic effect of TiO_2 towards in-situ carbon deposition during sensing which resulted in a large drop in resistance. In the SnO_2-ZnO system, both single crystal Zn_2SnO_4 nanowires and SnO_2-ZnO core-shell nanowires were obtained depending on the growth conditions. These nanostructures showed improved selectivity towards ethanol. However, the loading of Pd nanoparticles onto Zn_2SnO_4 shifts the selectivity towards H_2 gas. Mechanisms of 1D nanostructure growth and gas sensing will be discussed.