

Supporting Information

SnO₂-ZnO-Fe₂O₃ tri-composite based room temperature operated dual behavior ammonia and ethanol sensor for ppb level detection

Ajay Beniwal^a, Sunny^{a*}

^a Department of Electronics and Communication Engineering, Indian Institute of Information Technology - Allahabad, Prayagraj, India, 211015.

Email : erajay116@gmail.com, *sunnymeharwal@gmail.com

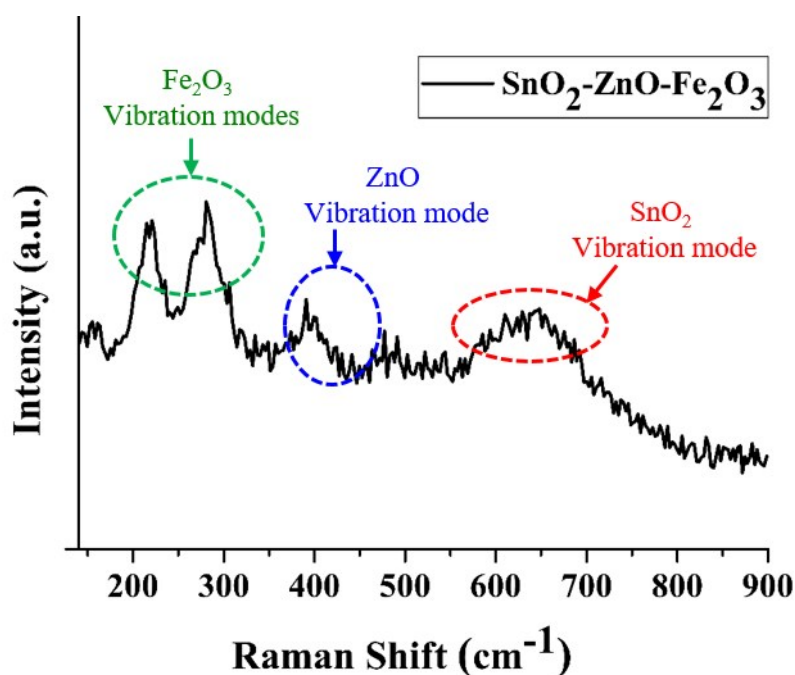


Figure S1. Raman spectra analysis of SnO₂-ZnO-Fe₂O₃ tri-composite.

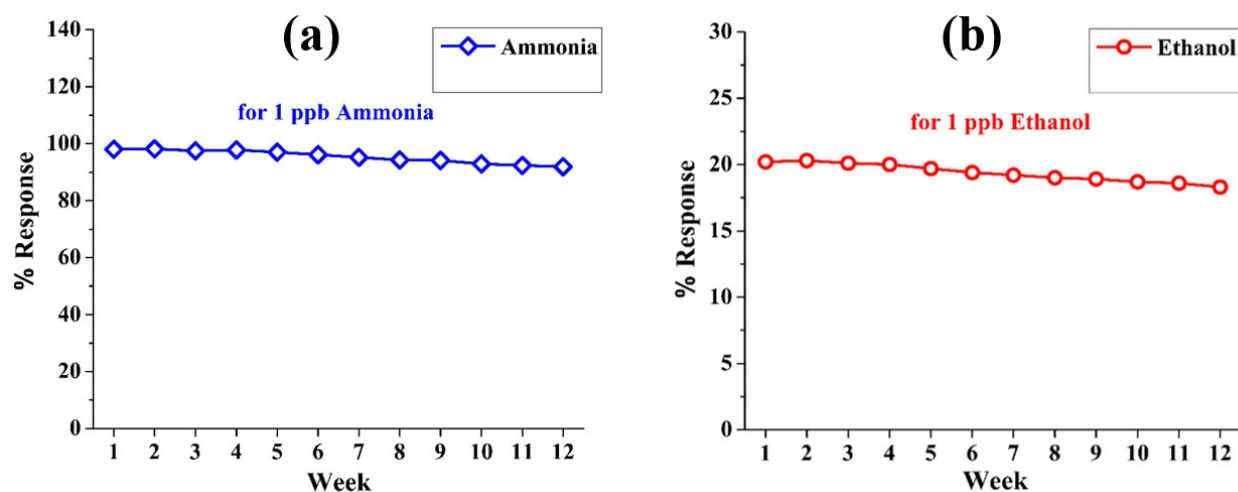


Figure S2. Aging effect analysis towards a fixed concentration (1 ppb) for (a) ammonia and (b) ethanol detection for 12 weeks.

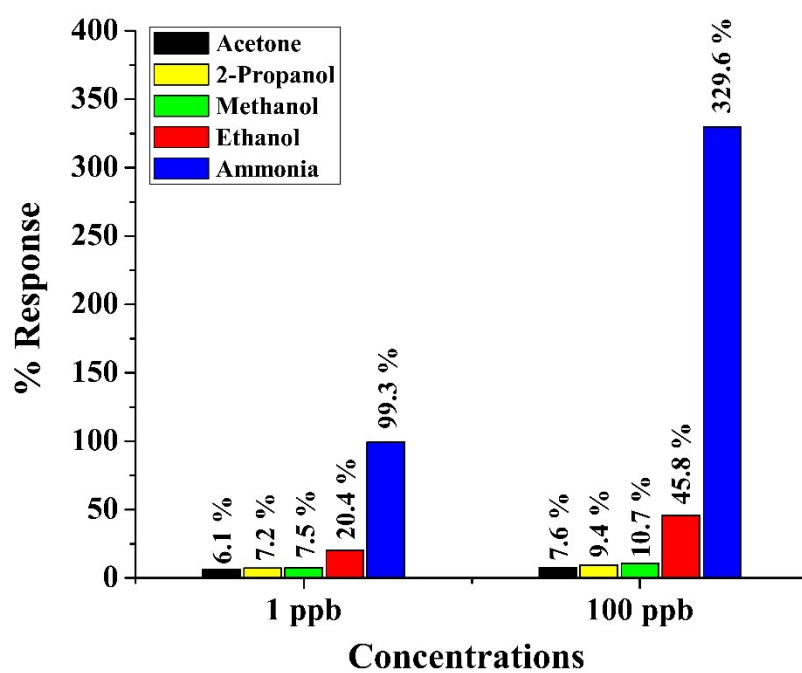


Figure S3. Selectivity analysis of the sensor for analytes viz. acetone, 2-propanol, methanol, ethanol and ammonia, under 1 ppb and 100 ppb concentrations.

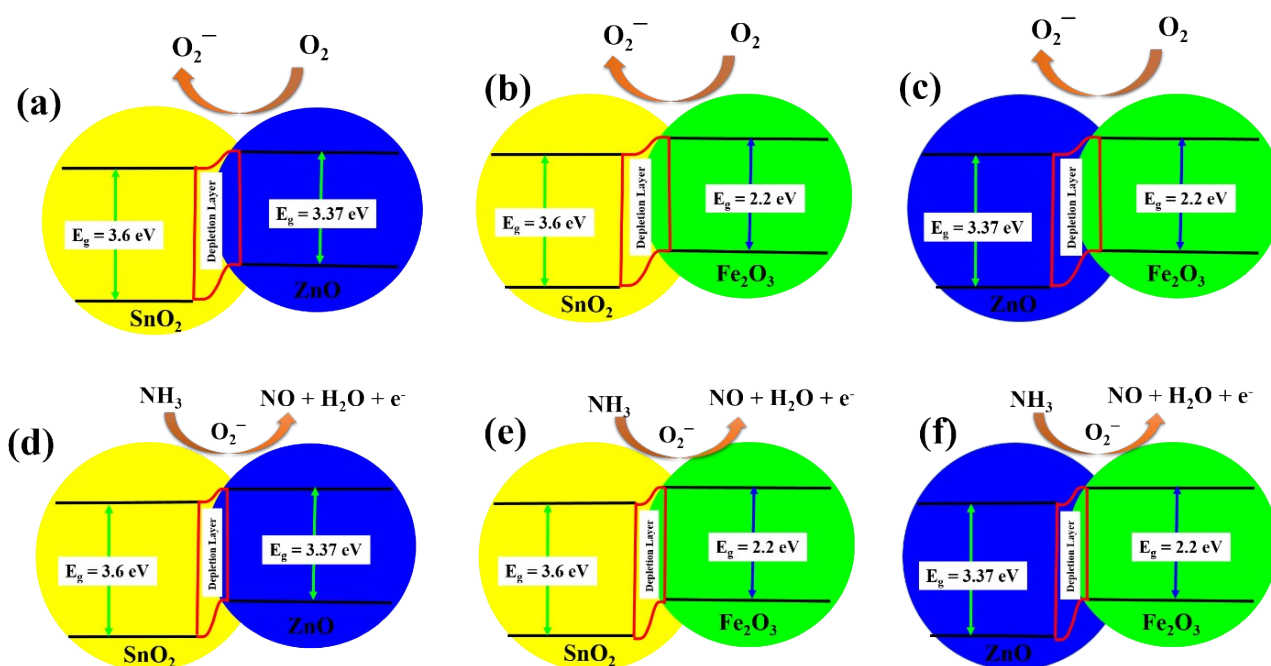


Figure S4. Proposed sensing mechanism based on n-n junction formation at metal oxide interfaces. (a-c) Schematic illustration of three possible n-n junctions forming electron depletion layers under air ambient. (d-e) Representation of reduced potential barrier across n-n junctions under ammonia exposure.

Table S1. Comparative study of the present work with existing literature reports for ammonia and ethanol detection.

Sr. No.	Material Used	Target Analyte	Operating Temp.	Concentration	Response / % Response	Response / Recovery Time	Year & Ref.
1	ZnO nanoflakes	Ammonia	250 °C	0.6 ppm - 3 ppm	~ 80 % for 3 ppm	3-15s / 5-14s	2020 ⁵³
2.	SnO_2 -ZnO-PPy	Ammonia	RT	70 ppm	~ 0.9	67.2s / 106.2s	2015 ⁵⁴
3.	(MoS_2 /ZnO) nanocomposite	Ammonia	RT	0.25 ppm - 100 ppm	9.28 % for 0.25 ppm	10s / 11s for 50 ppm	2017 ⁵⁵
4.	Cellulose/TiO ₂ /PANI composite nanofibers	Ammonia	RT	10 ppm - 250 ppm	0.584 for 10 ppm	--/--	2016 ⁵⁶
5.	Al doped ZnO/CuO nanocomposite	Ammonia	RT	50 ppm - 500 ppm	10.01 for 50 ppm	14s / 9s for 500 ppm	2018 ⁵⁷
6.	Pt/NiO	Ammonia	200 °C - 350 °C	10 ppb - 1000 ppm	1278 for 1000 ppm	15s / 76s for 1000 ppm	2018 ⁵⁸
7.	PANI/ α - Fe_2O_3	Ammonia	RT	5 ppm - 200 ppm	14.2 % for 5 ppm	~ 10s / 60s	2019 ⁵⁹

8.	Mn- doped ZnO nanoparticle	Ammonia	150 °C	20 ppm - 100 ppm	28.58 for 100 ppm	4s / 10s for 20 ppm	2017 ⁶⁰
9.	Boron-doped few-layer graphene nanosheet	Ammonia	RT	16 ppm - 256 ppm	8.92 % for 32 ppm	0.85s / 36.31s	2019 ⁶¹
10.	Ag/ZnO flower and nanoellipsoids	Ammonia	150 °C	10 ppm - 100 ppm	0.7 for 10 ppm	13s / 20s for 10 ppm	2018 ⁶²
11.	Co ₃ O ₄ /SnO ₂ nanospheres	Ammonia	200 °C	5 ppm - 2000 ppm	1.6 for 5 ppm	4s /17s for 50 ppm	2016 ⁶³
12.	ZnO nanostructure	Ethanol	350 °C	100 ppm - 600 ppm	30.4 for 400 ppm	10s / 4s	2018 ⁶⁴
13.	Horseshoe-shaped SnO ₂	Ethanol	225 °C	10 ppm - 200 ppm	17.3 for 100 ppm	8s / 780s for 100 ppm	2017 ⁶⁵
14.	Pb-Doped In ₂ O ₃ Nanostructures	Ethanol	250 °C	1 ppm - 2000 ppm	32.57 for 100 ppm	2.2s / 0.7s for 100 ppm	2017 ⁶⁶
15.	In ₂ O ₃ Nanocubes	Ethanol	300 °C	5 ppm - 100 ppm	7 for 10 ppm	15s / 700s for 100 ppm	2020 ⁶⁷
16.	SnO ₂	Ethanol	350 °C - 450 °C	100 ppm	110.9 at 450 °C	2s / 708s at 450 °C	2019 ⁶⁸
17.	Fe ₂ O ₃ Nanoporous network	Ethanol	350 °C - 450 °C	10 ppm - 1000 ppm	2.57 for 10 ppm at 400 °C	less than 5s / relatively long	2018 ⁶⁹
18.	Carbon nitride decorated Co ₃ O ₄	Ethanol	180 °C - 250 °C	500 ppm	30.2 at 210 °C	93s / 87s at 210 °C	2018 ⁷⁰
19.	SnO ₂	Ethanol	350 °C - 450 °C	20 ppm - 1000 ppm	37.2 for 20 ppm at 190 °C	63s / 20s for 300 ppm at 190 °C	2020 ⁷¹
20.	Fe–ZnO mesoporous nanoparticles	Ethanol	160 °C - 400 °C	100 ppm	319.8 at 320 °C	39s / 29s at 320 °C	2020 ⁷²
21.	SnO ₂ nanowire	Ethanol	RT	10 ppm	--	4s / 11s	2015 ⁷³
22.	SnO ₂ /TiO ₂ Nanobelt	Ethanol	43 °C - 276 °C	10 ppm to 500 ppm	11.2 for 10 ppm at 43 °C	40 min / 5 min	2015 ⁷⁴
23.	α-Fe ₂ O ₃ Nanospheres	Ethanol	240 °C	100 ppm	13.4	0.5 s / 7s	2015 ⁷⁵
24.	SnO₂-ZnO-Fe₂O₃ tri-composite	Ammonia	RT	1 ppb to 50 ppm	99.3% for 1 ppb and 1893.1% for 50 ppm	~ 2s / 10 s for 1 ppb	This Work
		Ethanol	RT	1 ppb to 25 ppm	20.4% for 1 ppb and 122.6% for 25 ppm	~ 2s / 4 s for 1 ppb	