Electronic Supplementary Information

Ultra-Sensitive Humidity Sensors Based on $ZnSb_2O_4$ Nanoparticles

Mianzeng Zhong[1], Zhongming Wei[2,*], Xiuqing Meng[1], Fengmin Wu[1] and Jingbo Li[1,3,*]

[1] Zhejiang Provincial Key Laboratory of Solid State Optoelectronic Devices, Zhejiang Normal University, Jinhua 321004, China

[2] Nano-Science Center & Department of Chemistry, University of Copenhagen, Universitetsparken 5, DK-2100 Copenhagen Ø, Denmark

[3] State Key Laboratory of Superlattices and Microstructures, Institute of Semiconductors, Chinese Academy of Sciences, P.O. Box 912, Beijing 100083, China

Email: jbli@semi.ac.cn and zmwei@semi.ac.cn

Humidity Testing of $ZnSb_2O_4$ NPs -based humidity sensor:

The relative humidity is controlled by the concentration of sulfuric acid, the Specific humidity value and the corresponding concentration of sulfuric acid are shown in Tab. S1.[1-4] The I-V curves of $ZnSb_2O_4$ nanoparticals in different RH atmosphere are recorded after humidity sensor is placed in the chamber with different RH in N_2 for 30 mins. The dynamic testing scheme of humidity sensing properties is shown in Fig.S2.[1]

Calculation of the crystallite size of the particles by Scherrer Formula.

The particle sizes of $ZnSb_2O_4$ were estimated from XRD patterns according to Scherrer Formula:

$$D_{(hkl)} = K\lambda / \beta \cos\theta \quad (1)$$

Where $D_{(hkl)}$ is the average particle size corresponding to the (hkl) crystalline plane, βis the full width of the peak at half of the maximum (FWHM) intensity (rad), λ the wavelength of X-ray radiation (1.54178Å), K is a constant related to the crystallite shape, and θ is the the Bragg angle (deg).[5, 6] The calculation results are shown in Tab.S2.

RH (%)	0	15	30	50	70	90	100
The concentration of sulfuric acid (w.t.%)	100	68	57	45	36	15	0

Tab. S1 The specific humidity value and the corresponding concentration of sulfuric acid.

Crystalline plane (h k l)	(200)	(211)	(220)	(310)	(202)	(330)	(411)	(420)	(213)	(332)
crystallite size(Å)	534	528	487	533	518	561	493	570	543	532

Table. S2 The crystallite size of $ZnSb_2O_4$ calculated by the Scherrer Formula to different Crystalline planes.

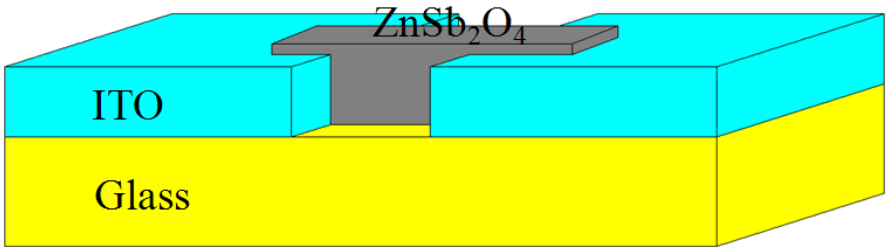

Fig. S1 Schematic of the $ZnSb_2O_4$ NPs-based humidity sensor.

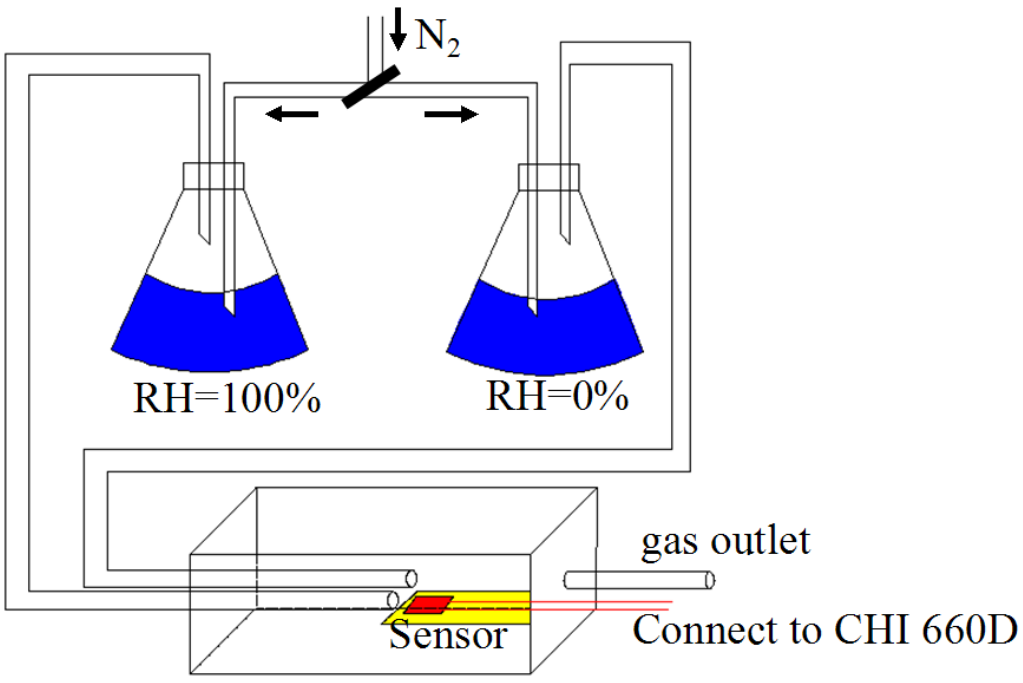

Fig. S2 Schematic for dynamic measurement of humidity sensing properties.

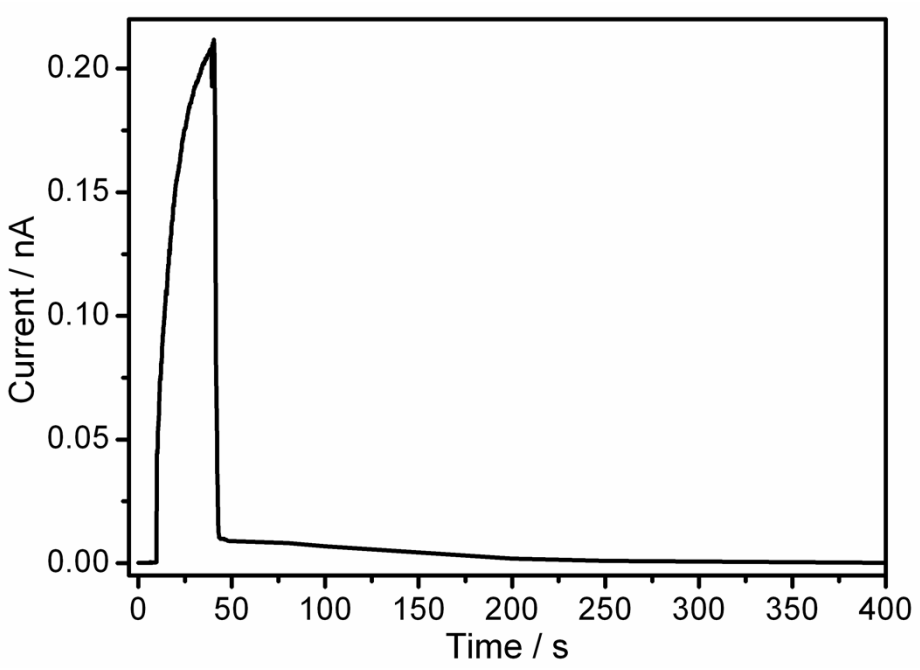

Fig. S3 A complete process of water molecules absorption-desorption.The response and recovery time under fast change of RH values between 0% RH in N_2 ("off" status) and 100% RH in N_2("on" status) .The bias voltage between two electrodes was kept constantly at 2.0 V.

References

S1 J. Feng, L. Peng, C. Wu, X. Sun, S. Hu, C. Lin, J. Dai, J. Yang and Y. Xie, *Adv. Mater.*, 2012, **24**, 1969-1974.

S2 S. Shankman and A.R. Gordon, *J. Am. Chem. Soc.*, 1939, **61**, 2370-2373.

S3 W. F. Giauque, E. W. Hornung, J. E. Kunzler and T. R. Rubin, *J. Am. Chem. Soc.*, 1960, **82**, 62-70.

S4 E. W. Hornung and W. F. Giauque, *J. Am. Chem. Soc.*, 1955, **77**, 2744-2746.

S5 B. Xue, P. Chen, Q. Hong, J. Lin and K, L. Tan, *J. Mater. Chem.*, 2001, **11**, 2378-2381.

S6 V. M. Rusu, C. H. Ng, M. Wilke, B. Tiersch, P. Fratzl and M. G. Peter, *Biomaterials*, 2005, **26**, 5414-5426.