Electronic Supplementary Information

The critical role of hydroxyl groups on water vapor sensing of Graphene oxide

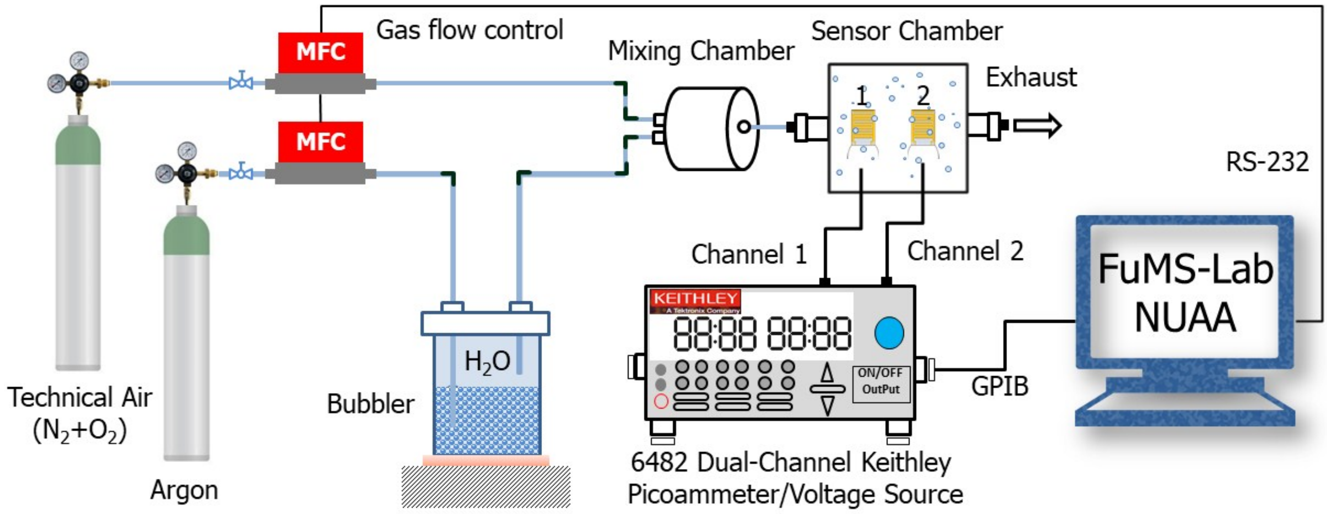
Qawareer Fatima[a],[b],† , Azhar Ali Haidry[a],[b],†,*, Zhengjun Yao[a],[b],*, Yue He[a],[b], Zhong Li[a],[b], Linchao Sun[a],[b], and Lijuan Xie[a],[b]

[a] College of Materials Science and Technology, Nanjing University of Aeronautics and Astronautics, 211100 Nanjing, China.

[b] Key Laboratory of Materials Preparation and Protection for Harsh Environment, Ministry of Industry and Information Technology, 211100 Nanjing, China.

[†] Authors contributed equally

[*] Corresponding author's email: aa.haidry@nuaa.edu.cn, azharalig2@gmail.com, yaozj@nuaa.edu.cn



Dynamic gas/humidity test unit

Figure S1: (color online) The schematic of custome design gas and humidity sensing test unit at **Fu**nctional **M**aterials and Chemical **S**ensors lab at College of Materials Science and Technology, Nanjing University of Aeronautics and Astronautics. The setup consists of high-purity gases connected via red-y mass flow controllers, gas mixing chamber, sensor chamber and electrical characterization unit operates with 6482 Dual-Channel Keithley picoammeter/voltage source. The setup can measure two samples at the simultaneously and the test unit is fully operated with LabVIEW software.

Static humidity test unit

In order to evaluate the actual response and recovery time, we designed a static test unit for humidity sensing. The system used a distilling tube as the chamber; the sample is inserted inside the distilling tube with two copper wires connected. Three necks of the distilling tube are seal up with two one-way glands and glue. The distilling tube is put in a boiling flask with two necks. Another neck is used to balance the pressure. Inside the boiling flasks, some chemical is been used to create humidity. The sample first is placed in dry air flask to get the stable base current. Then the sample is inserted in the flask with wet air. A pump is used to push the gas in the flask in to the distilling tube. With this system, the response and recovery time is closer to the actual surface reaction time.

Table S1: The relationship between chemical solution and humidity.

Humidity	Formula	Humidity (%rh)	Formula
4	CSF	7	LiBr
11	LiCl	23	CH_3COOK
33	$MgCl_2$	43	K_2CO_3
59	NaBr	70	KI
75	NaCl	85	KCl
98	K_2SO_4		

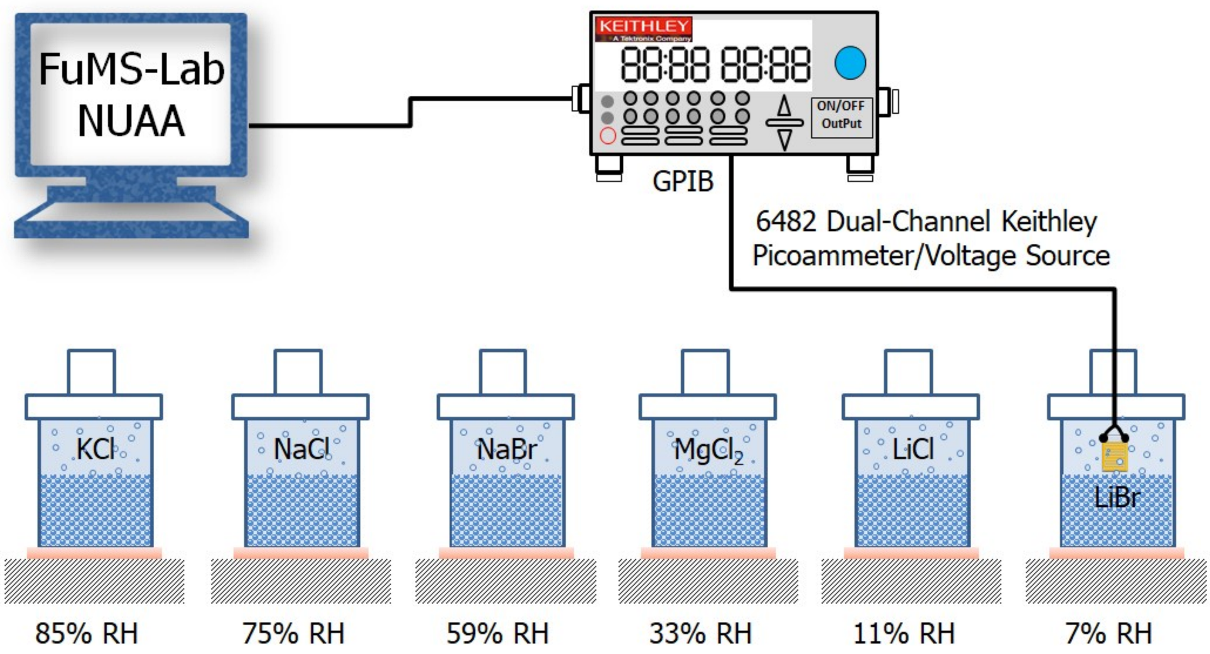


Figure S2: (color online) The schematic of custom-design static humidity test system is shown in this figure. The electrical current was again measured with 6482 Dual-Channel Keithley picoammeter/voltage source.

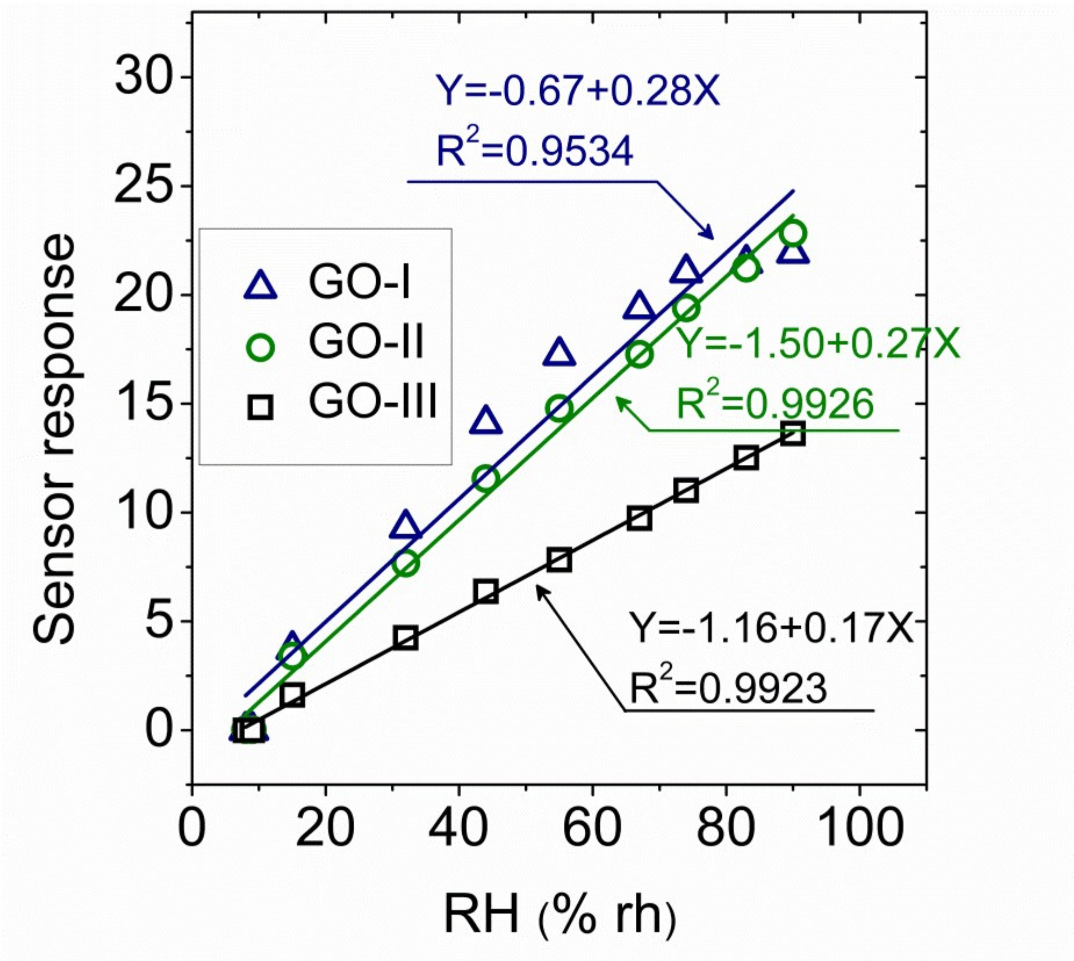


Figure S3: (color online) The linear relationship of sensor response with increased humidity (%rh) of GO-I, GO-II and GO-III sensors, the plot also shows the measured R-square value along with fitted equation of line.

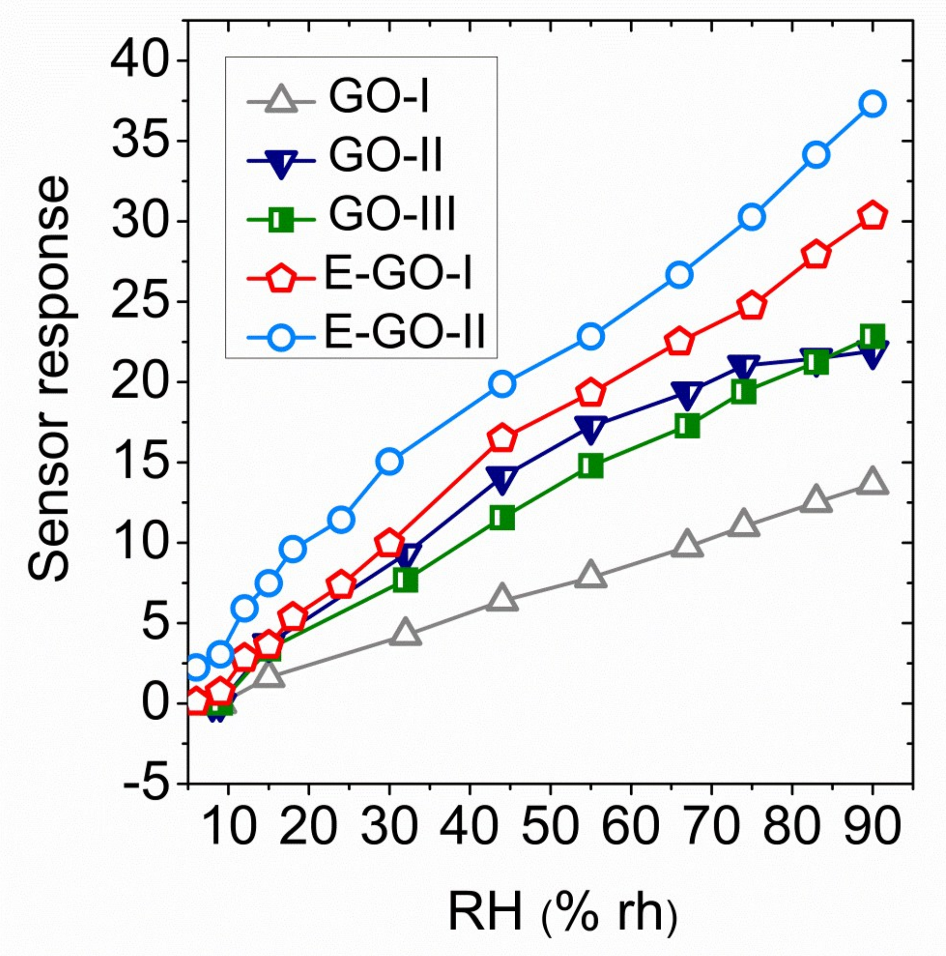


Figure S4: (color online) The comparison of sensor response of GO-I, GO-II, GO-II, E-GO-I, and E-GO-II samples.

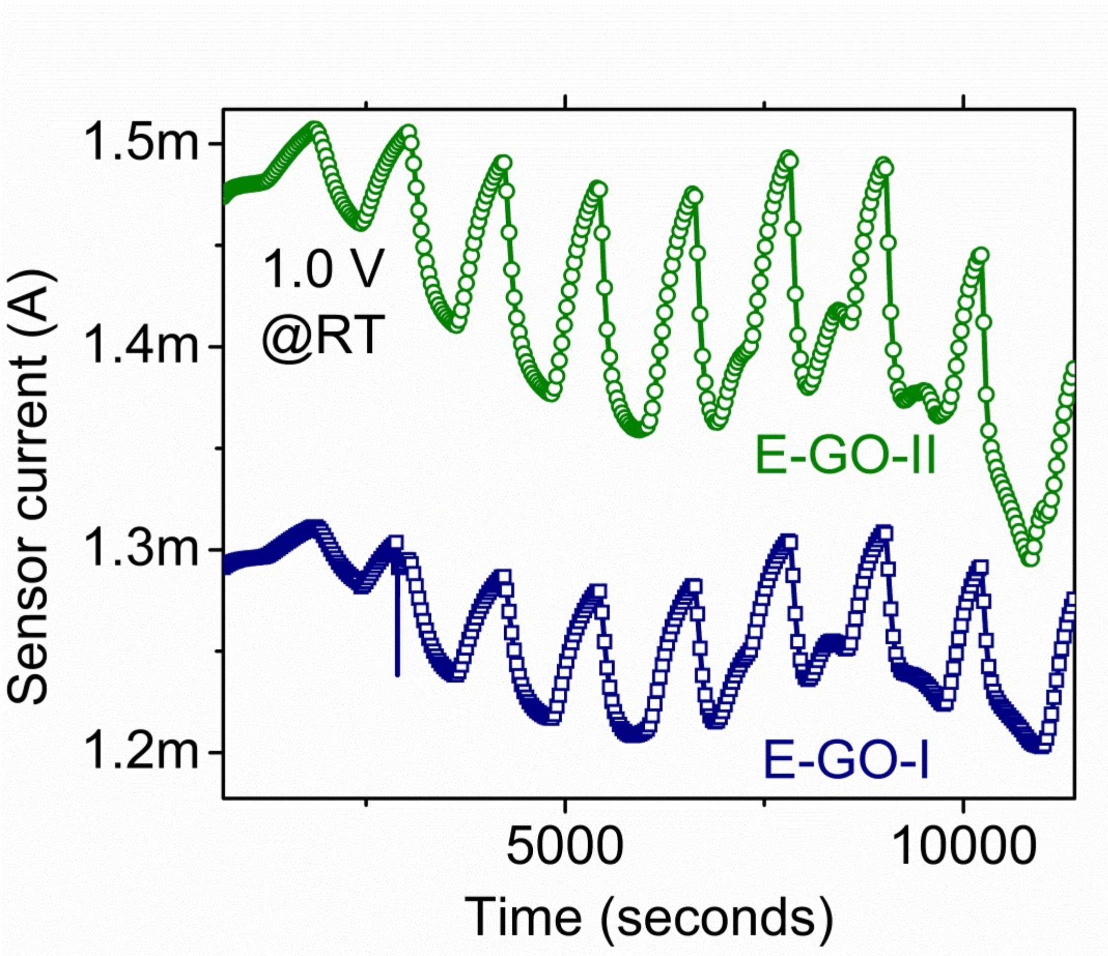


Figure S5: (color online) The dynamic responses of E-GO-I and E-GO-II sensors at 1.0 applied voltage.

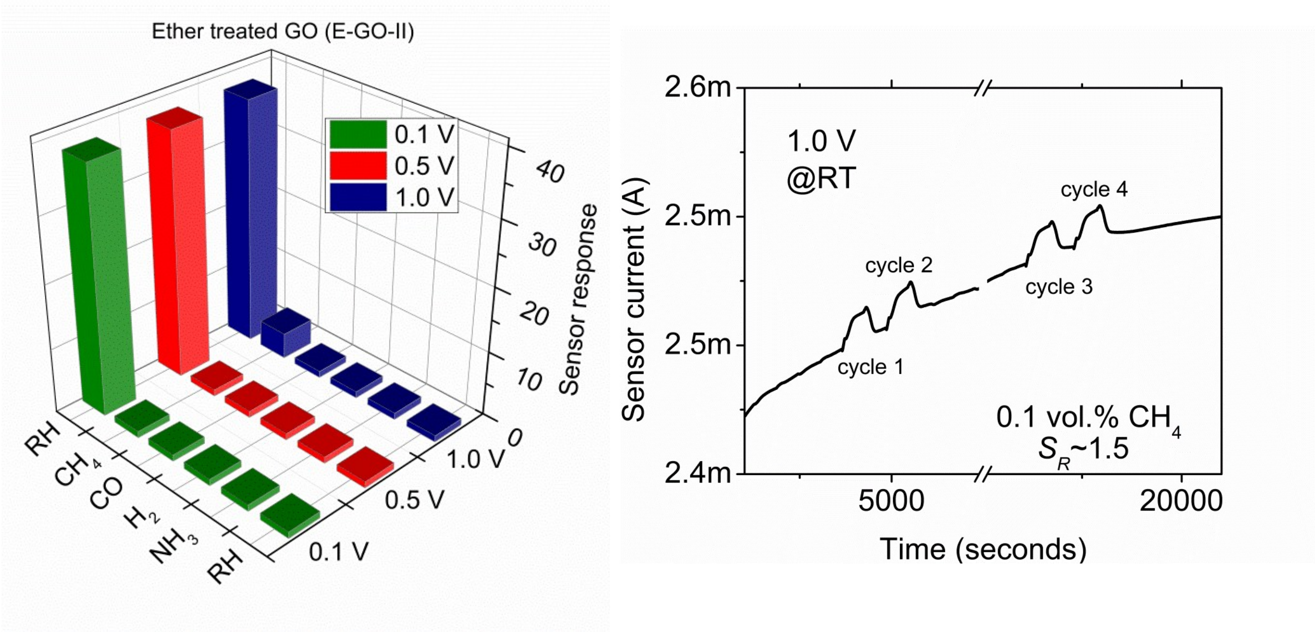


Figure S6: (color online) The humidity selectivity of ether treated E-GO-II sensor again other gases are shown in figure on the left. One of the typical dynamic response of E-GO-II sensor toward 0.1 vol.% CH_4 at room temperature with 1.0 V applied voltage, the estimated sensor response value is also mentioned in the figure on right.

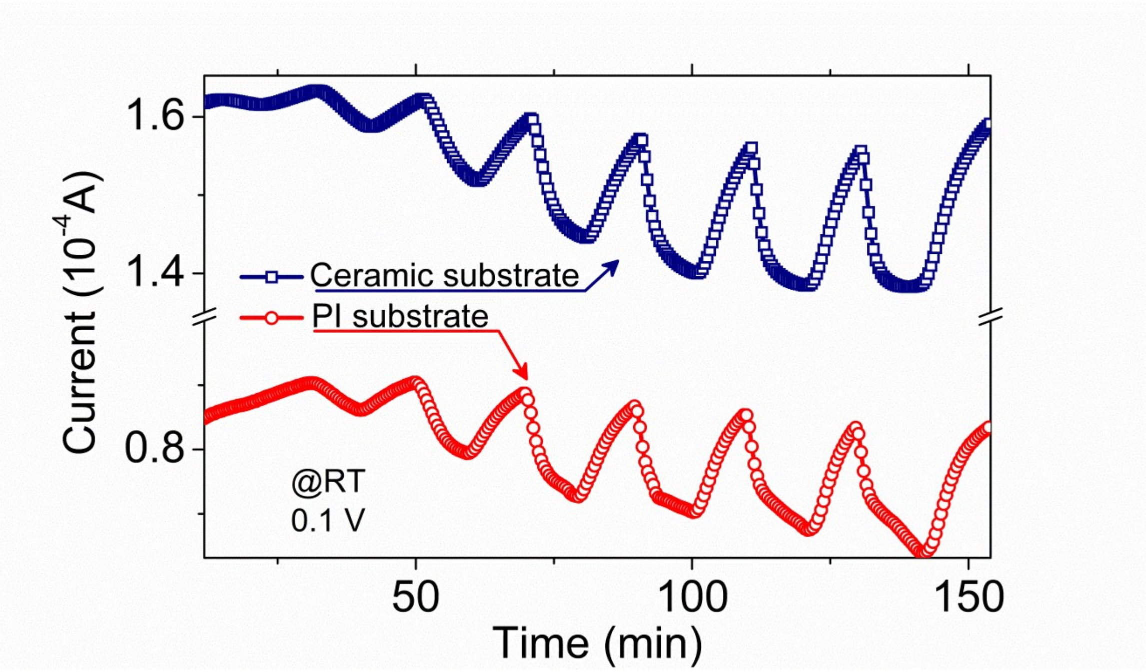


Figure S7: (color online) Comparative plot of E-GO-II sensor prepared on ceramic substrate (blue color; open box symbol) and PI substrate (red color; open circle symbol) measrued at room temperature with 0.1 V applied voltage.

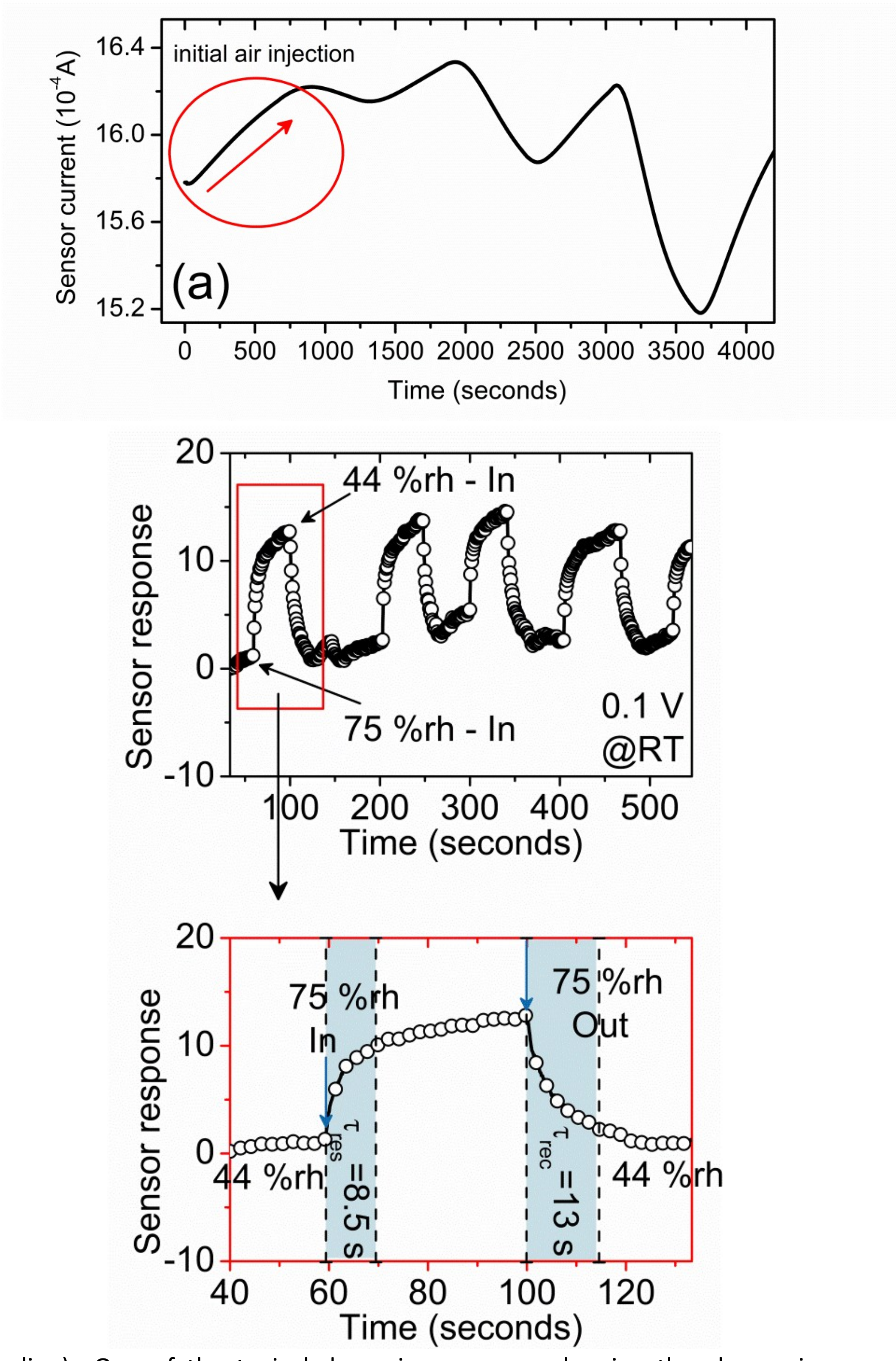


Figure S8: (color online) One of the typical dynamic responses showing the change in sensor current upon first air injection (a). The typical responses of E-GO-II sensor measured with static humidity test unit with 0.1 V at room temperature, the typical dynamic response also shows fast response and recovery times.

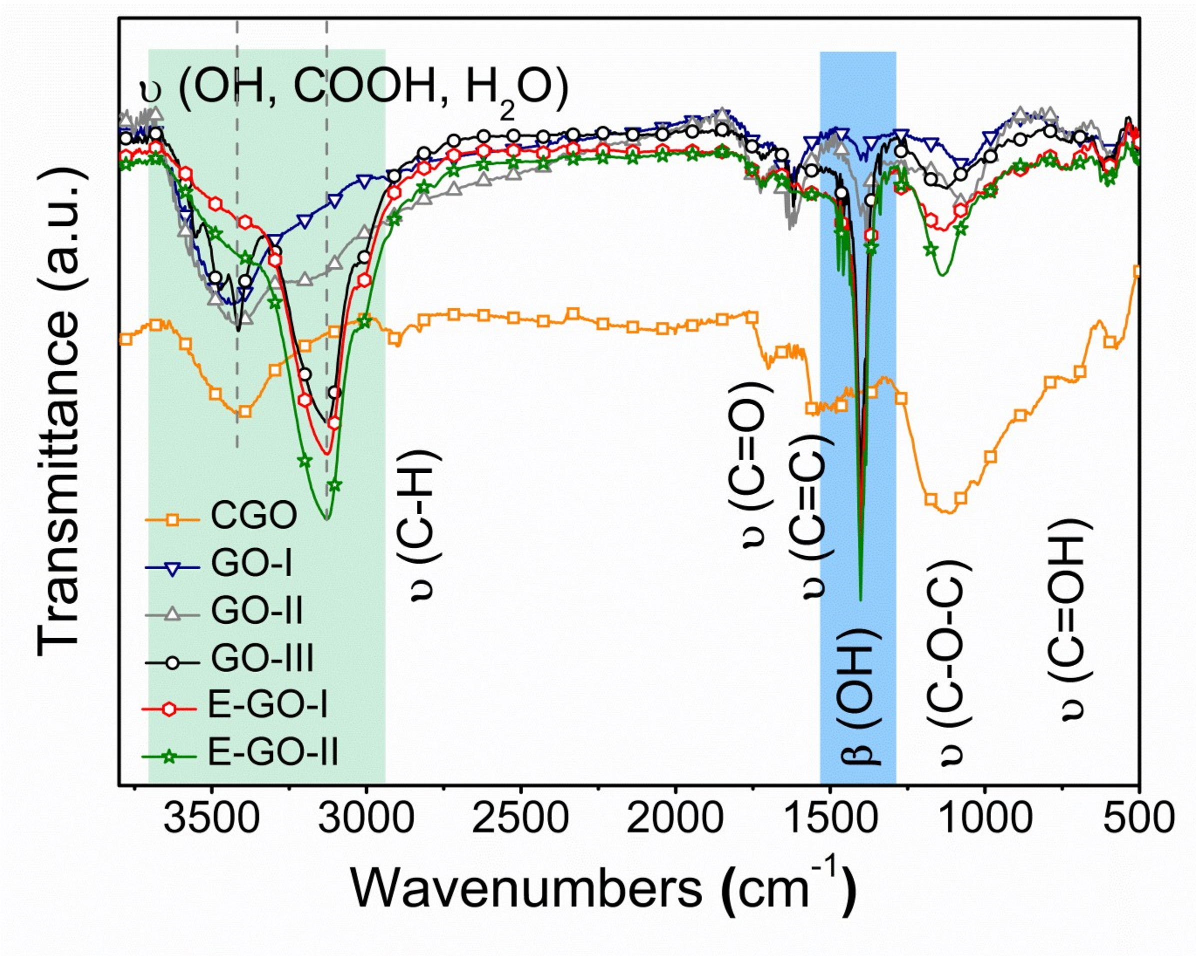


Figure S9: (color online) The FT-IR spectra of CGO, GO-I, GO-II, GO-III, E-GO-I, and E-GO-II are shown here.

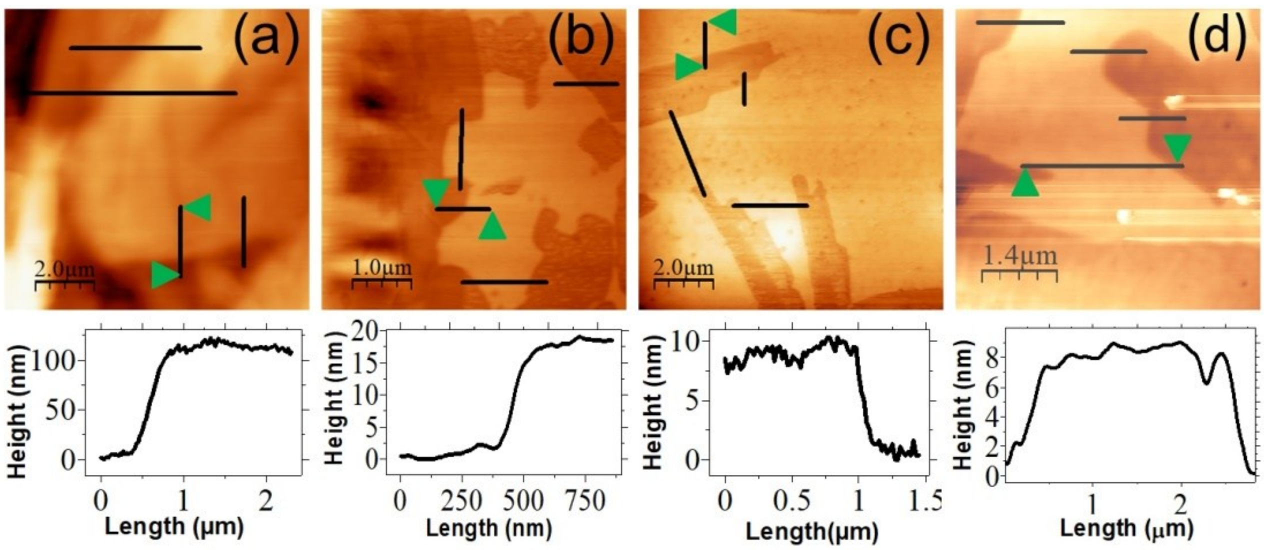


Figure S10: (color online) The AFM topographs of CGO, GO-I, GO-II, GO-III, E-GO-I, and E-GO-II are shown here.

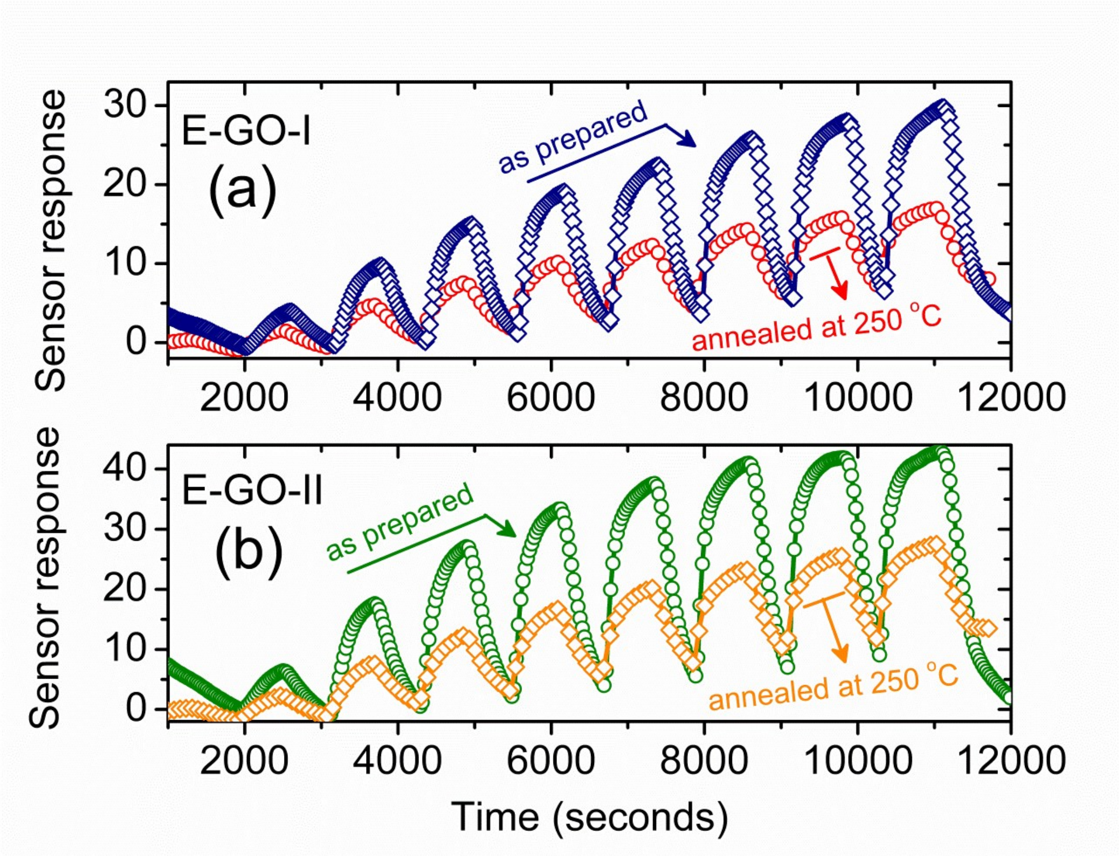


Figure S11: (color online) The comparison of un-annealed and annealed (at 250 °C) samples measured at room temperature with 0.1 V applied voltage to various humidity ranging from 11 to 90% rh.