Electronic Supplementary Information

Resistive Graphene Humidity Sensors with Rapid and Direct Electrical Readout

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Figure S1 shows the Raman spectrum of graphene both grown in house in a) as well as graphene grown in Graphenea in b). There are several important things to note about the graphene. First, the presence of monolayer graphene is confirmed by the peak location for both G and 2D peaks as well as their peak intensity. Note further that neither the in house graphene nor the commercial material from Graphenea contain an appreciable defect peak – demonstrating that the quality of the graphene in both cases is very good.

The graphene is grown first through the nucleation of carbon on the copper, followed by the formation of grains as the nucleation continues. These grains eventually merge – leading to a continuous graphene layer. Growth parameters are optimized to obtain a single continuous graphene layer (0.3 nm). The graphene is polycrystalline.

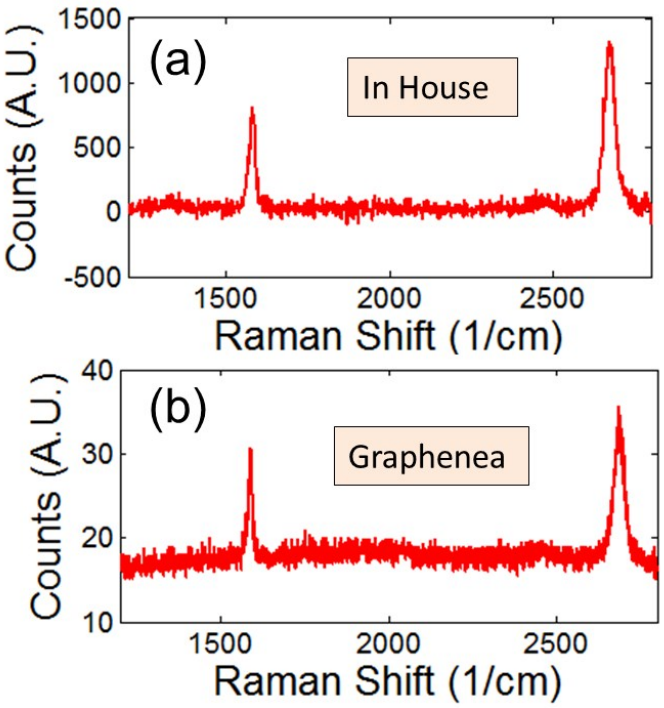

Figure S1: a) Raman spectrum of graphene for CVD graphene grown in house. b) Raman spectrum of graphene grown by Graphenea.

The effects of temperature on the devices have been examined for both convective cooling of the devices as well as Joule heating. To explore the possibility of convective cooling, the temperature of the area around the devices is constantly monitored through the use of an LM35 temperature sensor. In order to address the effects of Joule heating, current is pulsed through the device with 200mV square wave pulses having a duration of 500 μs.

Figure S2 shows the temperature changes near the device as air is pumped in and out of the chamber. Note that, there is very little change in temperature as air is pumped in and out. Further, there is very little signal response of the device as different gasses are pumped in – despite variations in temperature. The only event which triggers a significant response is the inflow of air – containing water vapor. This is a very strong indication that humidity is the primary mechanism driving the observed signal change.

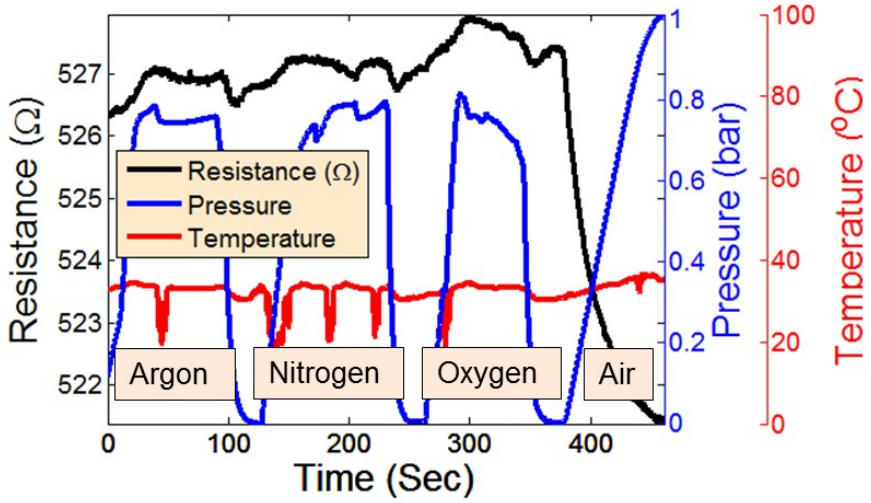

Figure S2: Device Resistance (black line) versus time measured simultaneously with chamber pressure (blue line) and temperature (red line)

Although steps were taken in order to mitigate the effect of drift in devices due to self-heating, sometimes a linear drift still occurs over time in some devices. The device shown in Figure 3e contained some drift which was subsequently de-embedded for clarity. The raw data is shown in Figure S3.

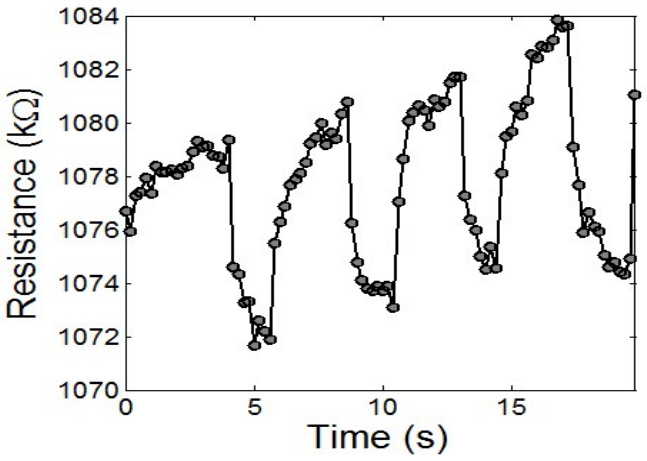

Figure S3: Raw data of Figure 3e before de-embedding residual drift.