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Parts-per-quadrillion Resolution Molecular Sensor Based on Pristine Carbon Nanotubes

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Single-walled carbon nanotube (SWNT) is probably the ultimate sensor among nanoscale semiconducting materials since a SWNT consists solely of surface so that every single carbon atom is in direct contact with the environment, allowing optimal interaction with nearby molecules. Ironically the ultrahigh sensitivity of SWNTs is easily compromised by various unintentional contaminants from the device fabrication process as well as the ambient environment. Here we show that applying continuous in situ ultraviolet (UV) light illumination during gas detection could dramatically enhance a SWNT-sensor's performance and for the first time achieve parts-per-quadrillion (PPQ) resolution with detection limit as low as 590 PPQ for nitric oxide detection at room temperature [1]. Gas detections on NO_2 and NH_3 further showed sensitivities 2 to 3 orders of magnitude better than what previously had reported. The much enhanced performance is apparently aroused from the UV light induced sensor surface cleaning. In addition, aiming for practical applications we illustrate how to address gas selectivity by introducing a gate bias.

[1] G. Chen, T. M. Paronyan, E. M. Pigos, and A. R. Harutyunyan, Scientific Reports 2, 343 (2012).