Supporting Information

Recycled Silicon Solar Cells-Derived Nanostructured *p*-Black Silicon for High Performance NO_2 Gas Sensor Applications

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Characterization Techniques:

p-Black Silicon derived from recycled solar cells were spectroscopically and microscopically characterized by various techniques. X-Ray diffraction (XRD) patterns were acquired using a Power X-ray diffractometer (Ultima IV, Rigaku, Japan) with Cu Kα radiation of wavelength 1.5418 Å at a scanning rate of 0.02°/sec in the 2θ range of 20°–80°. Micro Raman studies on *p*-Black Silicon was performed using confocal Raman microscope (WiTec, 300 Alpha, Germany) with He-Cd laser (λ = 532 nm) as the excitation light source and 600 g/mm gratings. The structure and morphology of the *p*-Black Silicon was examined using Field Emission Scanning Electron Microscopy (ZEISS EVO 18, US), with in-built energy-dispersive X-ray spectrometer (Oxford Instruments, INCA, UK).

Evaluation of NO_2 gas sensing properties

The sensor device was fabricated using DC magnetron sputtering of gold thin films with ~300 nm thickness directly on the etched *p*-B-Silicon substrate using a laser machined stainless steel mask. The gas sensing properties of the materials were analyzed using a custom-built gas sensor test station consisting of a stainless-steel double-walled test chamber equipped with temperature-controlled hot stage, sensor holder, mass flow controllers (MFC, Alicat, USA), digital multimeter (Agilent 34401A, USA) connected with a data acquisition system interfaced with Labview software. During measurements, NO_2 gas was mixed with dry nitrogen to achieve the desired concentrations and the flow rate was maintained as 300 sccm using mass flow controllers (Alicat, U.S.A.). A temperature controller (Eurotherm, 2420, U.K.) was used to maintain the working temperature of the sensor mounted inside the sensing chamber. Constant gas pressure was maintained in the sensing chamber (710 Torr) throughout the testing, which was measured using Baratron 722B Absolute Capacitance Manometer (MKS Instruments, Singapore). In order to perform the interference studies, NH_3, H_2S, ethanol, and acetone were individually exposed to the sensor device by keeping the constant concentration using Owlstone gas generator unit (OVG-4, U.K.) the sensor response was measured. 35W HID kit Xenon source was used for light illumination.

Table S1 NO_2 Sensing properties of *p*-B-Silicon under lower concentration.

Conc. of NO_2 (ppm)	***p*-B-Silicon**		
	Response $[(R_g - R_a)/R_a]$ S (%)	Response time (s)	Recovery time (s)
1	10.99	14.2	78.4
2	17.20	17	116.4
3	32.80	17.6	162
4	40.40	24.8	246.2
5	43.08	25.2	282.6

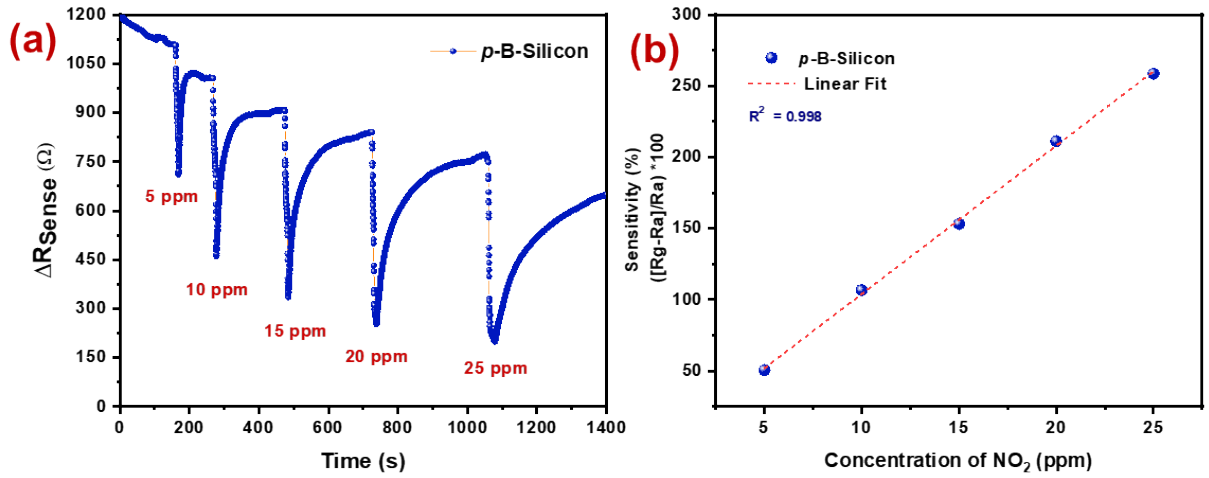

Figure S1 (a) Dynamic NO2 sensing characteristics of p-B-Silicon and (b) NO_2 response as a function of concentration.

Table S2 NO_2 Sensing properties of *p*-B-Silicon under higher concentration.

Conc. of NO_2 (ppm)	***p*-B-Silicon**		
	Response $[(R_g - R_a)/R_a]$ S (%)	Response time (s)	Recovery time (s)
5	50.50	10	32.2
10	106.63	11.4	92.2
15	153.13	12.2	191
20	211.19	14.2	279.8
25	258.69	17.4	305.6

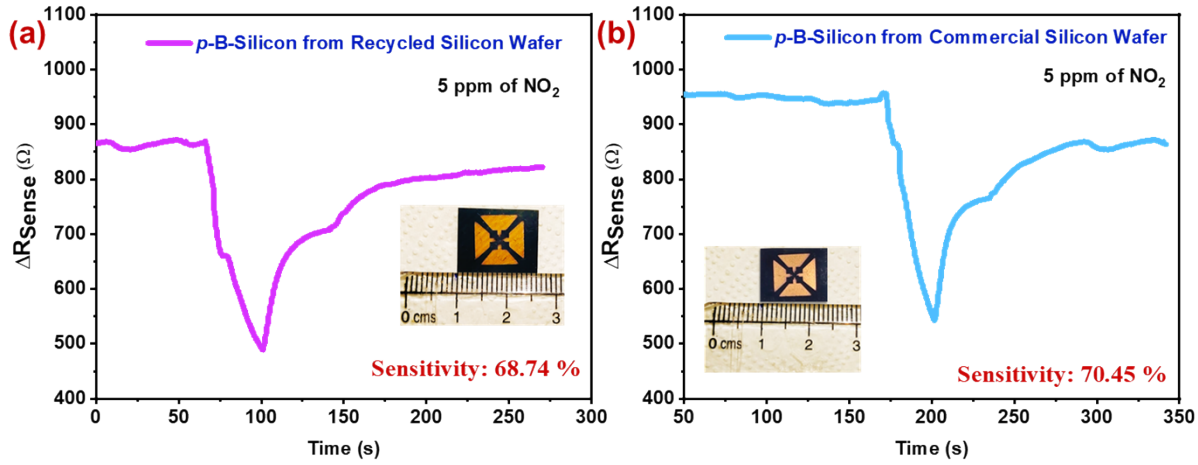

Figure S2 Dynamic NO_2 response-recovery graph of *p*-B-Silicon (a) recycled silicon wafer and (b) commercial silicon wafer.

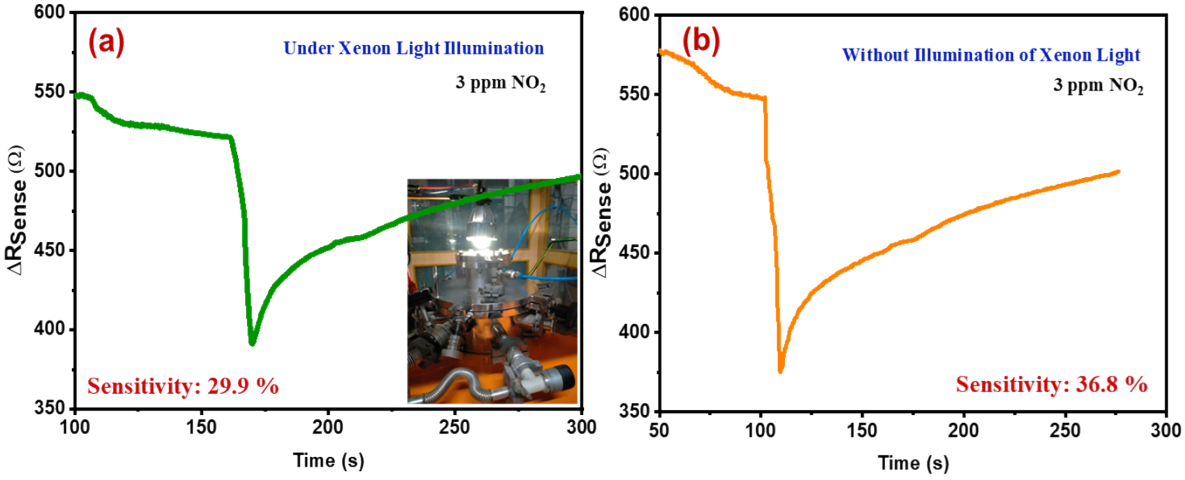

Figure S3 Dynamic NO_2 sensing characteristics of p-B-Silicon (a) without Xenon light illumination and (b) under Xenon light illumination.

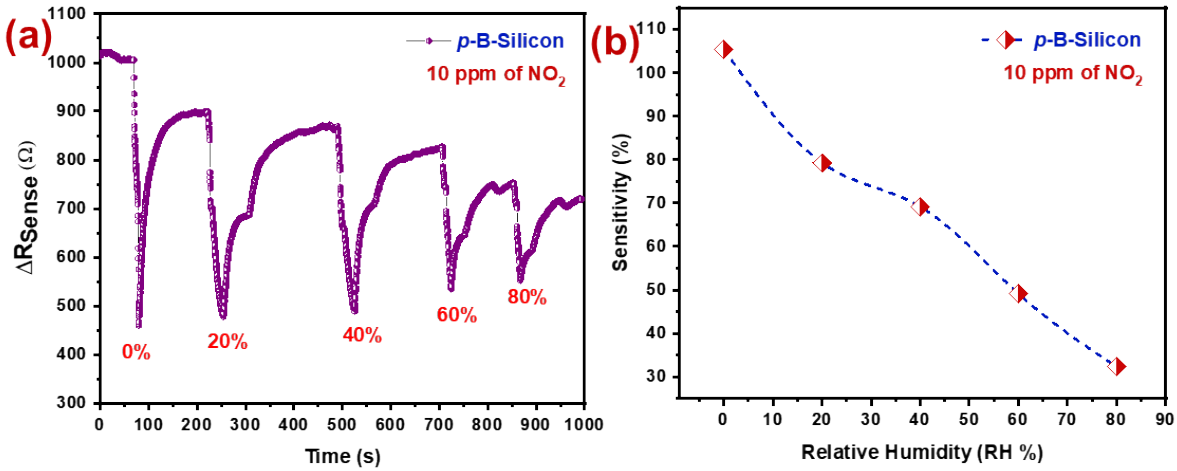

Figure S4 Relative humidity interference studies of p-B-Silicon (a) NO_2 response-recovery graph and (b) relative humidity (RH) versus sensitivity graph.