

Uniform 2D Semiconducting Carbon Nanotube Networks For Photodetection Applications

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Abstract

Single Walled Carbon Nanotubes (SWCNTs) are characterized by their outstanding properties. From high mechanical flexibility to high thermal and chemical stability. Moreover, in the optoelectronics domain, SWCNTs are promising materials due to their distinct properties including tunable band gaps [1], high electrical mobility and conductivity [2]. The field of photodetection in the near infra-red [3] is of increasing demand since it is highly applicable in various domains, while challenges related to developing materials and devices that are highly sensitive in the NIR spectral range are under investigation. Hereby, we use highly uniform and strongly connected 2D semiconducting SWCNTs in the fabrication of a high responsivity photosensor. The 2D CNT networks were fabricated via dip-coating, enabling precise control over film uniformity, thickness, and connectivity across large areas. After the CNT films were deposited onto silicon substrates, Platinum electrodes separated by 100 μ m were deposited on top of the SWCNT network by Focused Ion Beam methods as shown in Figure 1.

Comprehensive characterization was conducted to evaluate the morphology, structure, and optoelectronic performance of the devices. Scanning electron microscopy and atomic force microscopy confirmed the formation of continuous and uniform CNT networks with nanometer-scale precision. Photoelectric measurements were carried out to study the light detection properties of the fabricated device. The time-resolved photoresponse was investigated using a 980 nm laser source. Figure 2 shows the clear and repeatable switching behavior of the device as the laser light was OFF/ON switched, demonstrating a stable and rapid photoresponse. The photocurrent increased significantly upon illumination and decays to the dark current level rapidly as the laser was switched off, indicating efficient carrier generation and collection in the CNT-Si hybrid structure.

References

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- [3] C. Liu, J. Guo, L. Yu, J. Li, M. Zhang, H. Li, Y. Shi, D. Dai, *Light: Science & Applications*, 10 (2021) 123.

Figures

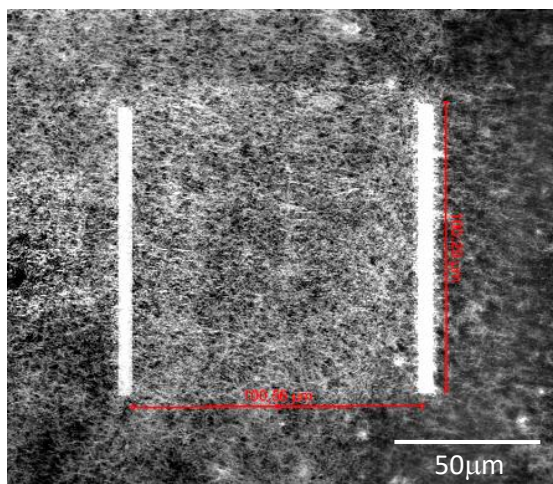


Figure 1: SEM image showing the 2D SWCNT network between the deposited Pt electrodes.

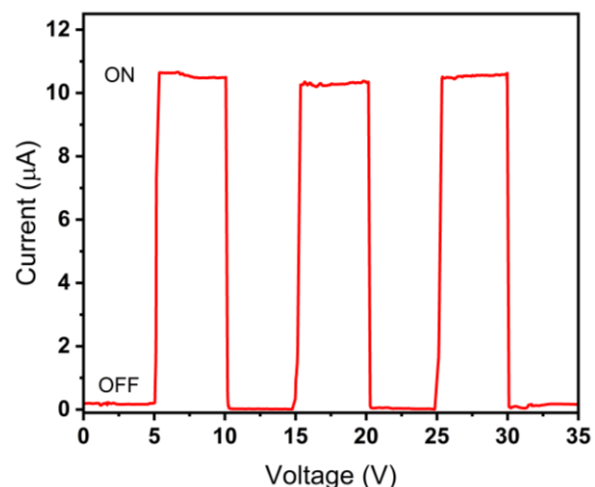


Figure 2: Photocurrent generation in response to near infra-red light illumination.