Highlights

RESEARCH AREA 2 - Functional and Complex Materials for Innovative Electronics and Sensing - 2024

Memory effect and coexistence of negative and positive photoconductivity in black phosphorus field effect transistor for neuromorphic vision sensors

Arun Kumar[1], Kimberly Intonti[1,2], Loredana Viscardi[1,2],Ofelia Durante[1,2], Aniello Pelella[3], Osamah Kharsah[4], Stephan Sleziona[4], Filippo Giubileo[2], Nadia Martucciello[2], Paolo Ciambelli[5], Marika Schleberger[4], Antonio Di Bartolomeo [1,2]

[1]Department of Physics 'E.R. Caianiello', University of Salerno, Via Giovanni Paolo II 132, Fisciano 84084, Italy
[2]CNR-SPIN Salerno, Via Giovanni Paolo II 132, Fisciano 84084, Italy
[3]Department of Science and Technology, University of Sannio, Via de Sanctis, Benevento 82100, Italy
[4]Fakultät für Physik and CENIDE, Universität Duisburg-Essen, Lotharstrasse 1, Duisburg D-47057, Germany
[5]Narrando Srl, Via Arcangelo Rotunno 43, Salerno 84134, Italy

MATERIALS HORIZONS

Black phosphorus (BP) field-effect transistors with ultrathin channels exhibit unipolar p-type electrical conduction over a wide range of temperatures and pressures. Herein, we study a device that exhibits mobility up to 100 $cm^2 V^{-1} s^{-1}$ and a memory window up to 1.3 µA. Exposure to a supercontinuum white light source reveals that negative photoconductivity (NPC) and positive photoconductivity (PPC) coexist in the same device. Such behavior is attributed to the chemisorbed O_2 molecules, with a minor role of physisorbed H_2O molecules. The coexistence of NPC and PPC can be exploited in neuromorphic vision sensors, requiring the human eye retina to process the optical signals through alerting and protection (NPC), adaptation (PPC), followed by imaging and processing. Our results open new avenues for the use of BP and other two-dimentional (2D) semiconducting materials in transistors, memories, and neuromorphic vision sensors for advanced applications in robotics, self-driving cars, *etc*.

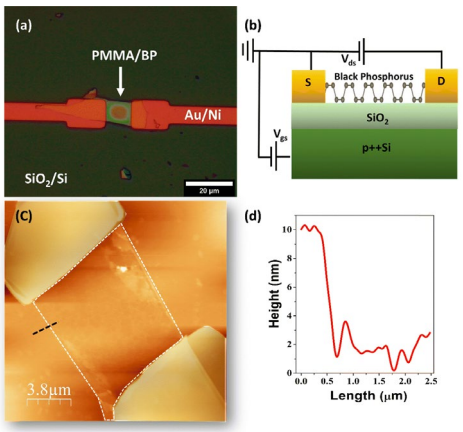

Fig. 1 (a) Optical image of the BP FET device. (b) Schematic diagram of the BP FET device. (c) AFM image of the BP FET device. (d) Height profile along the black line over the BP channel.

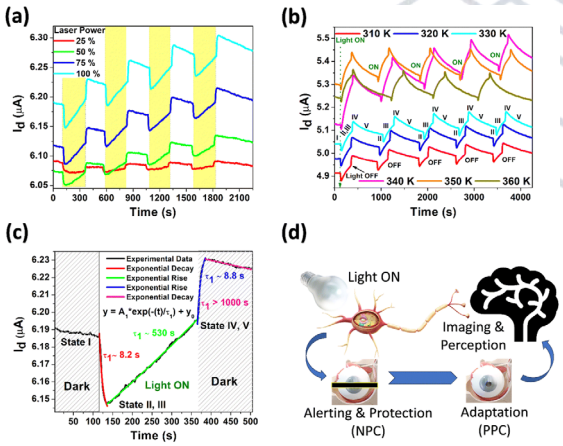

Fig. 2(a) Transient photocurrent at different laser powers at 310 K, V_{ds}= 10 mV. (b) Transient photocurrent at different temperatures with a maximum laser power, at V_{ds}= 100 mV. In both cases, the maximum laser power was 110 mW, 10^{-5}mbar pressure, and V_{gs} = 0 V. (c) Current decay/rise and exponential fit at 310 K, 10^{-5}mbar pressure. (d) Corresponding illustration of the obtained NPC and PPC for neuromorphic vision sensors.

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