Defect induced optoelectronic applications of layered black phosphorus

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Black phosphorus (BP) has attracted significant attention owing to its exotic electronic and optoelectronic properties that are easily tunable [1, 2]. The broadband photoabsorption of BP, ranging from ultraviolet (UV) to infrared [3, 4], and strong light-matter coupling [5] render it an ideal layered material for opto-electronic applications and devices which can manipulated their photoresponse under different excitation wavelengths. Here we show that ambient oxidation induced trap sites lead BP to exhibit a unique photoresponse in different UV wavelengths, i.e., positive photocurrent under 280 nm (UV-B, Fig. 1a) and negative photocurrent in 365 nm (UV-A, Fig. 1b) illuminations. We exploit this unique photoresponse of BP for selective sensing of UV band radiation. Also, we employ positive and negative photocurrent of BP to mimic excitatory and inhibitory action potentials, respectively, in a biological synapse. Furthermore, we demonstrate all-optical BP synaptic devices capable of imitating key neural behaviors such as psychological learning and forgetting, pulsed-pair facilitation and spatiotemporally correlated dynamic logic.

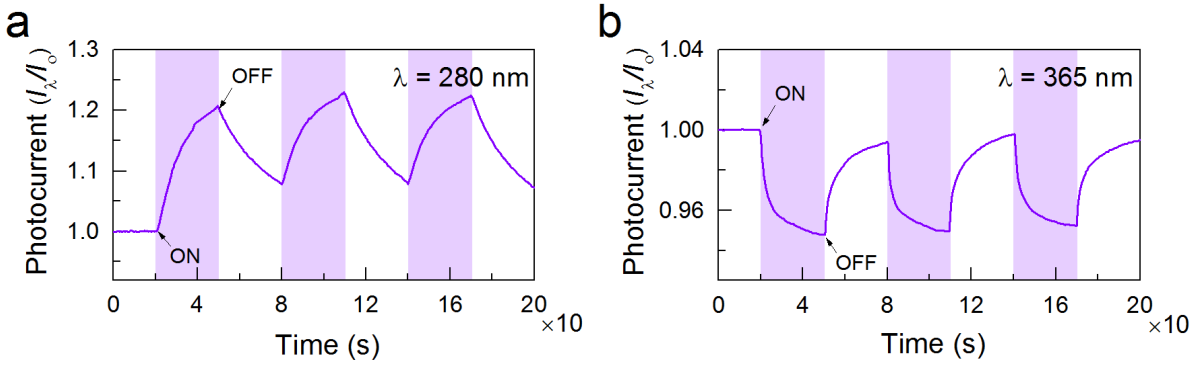

Figure. 1. Photoresponse of a BP photo-transistor under (a) 280 nm illumination, exhibiting a positive photocurrent, and (b) 365 nm illumination, exhibiting a negative photocurrent.

References

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