Electronic Supplementary Information for

Catalyst-free growth of two-dimensional hexagonal boron nitride few-layers on sapphire for deep ultraviolet photodetectors

Menglei Gao[a,b], Junhua Meng*[c], Yanan Chen[a,b], Siyuan Ye[d], Ye Wang[a,b], Congyu Ding[a], Yubo Li[d], Zhigang Yin[a,b], Xiangbo Zeng[a,b], Jingbi You[a,b], Peng Jin[a,b] and Xingwang Zhang*[a,b]

[a] Key Lab of Semiconductor Materials Science, Institute of Semiconductors, Chinese Academy of Sciences, Beijing 100083, P. R. China

[b] Center of Materials Science and Optoelectronics Engineering, University of Chinese Academy of Sciences, Beijing 100049, P. R. China

[c] College of Applied Sciences, Beijing University of Technology, Beijing 100124, P. R. China

[d] Key Laboratory of Micro-Nano Electronic Device and Smart System of Zhejiang Province, College of Information Science & Electronic Engineering, Zhejiang University, Hangzhou 310027, P. R. China

E-mail: jhmeng@semi.ac.cn, xwzhang@semi.ac.cn

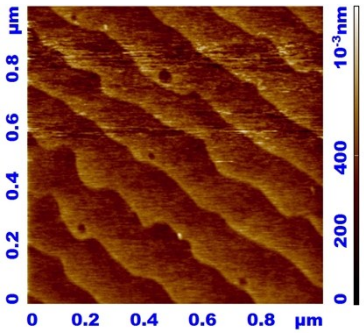

Fig. S1. The AFM image of sapphire substrate, showing typical terrace structure.

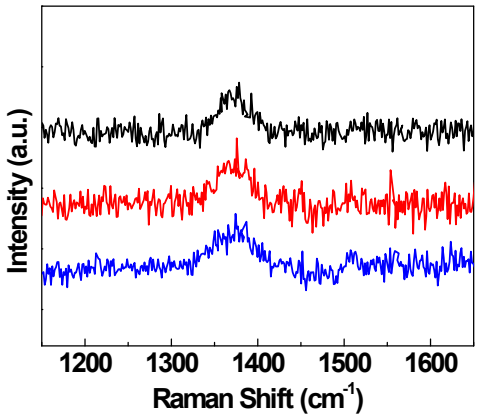

Fig. S2. Raman spectra collected from different locations of the h-BN layers directly grown on sapphire by IBSD using Ar ion beam.

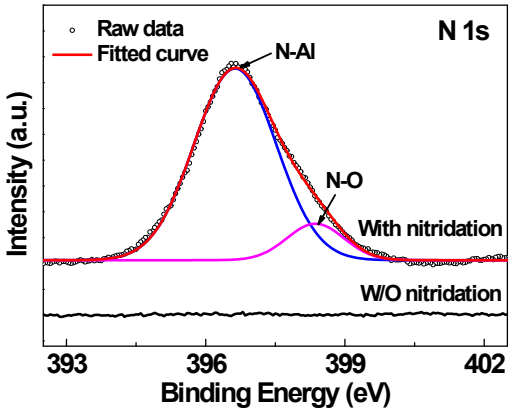

Fig. S3. XPS spectra of the sapphire substrate with and without a surface nitridation process.

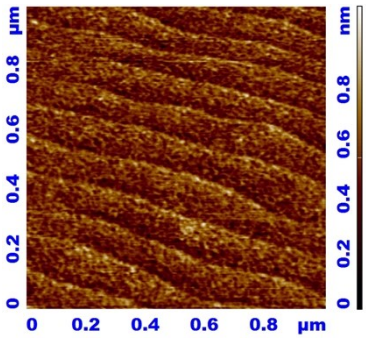

Fig. S4. The AFM image of sapphire surface after 10-min surface nitridation. The typical step-terrace structure is still preserved.

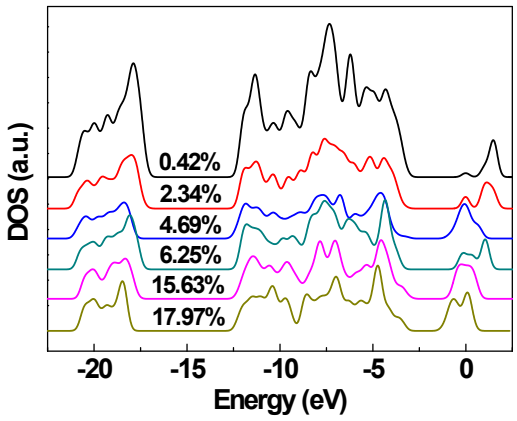

Fig. S5. The calculated DOS of h-BN with different N vacancy concentrations.

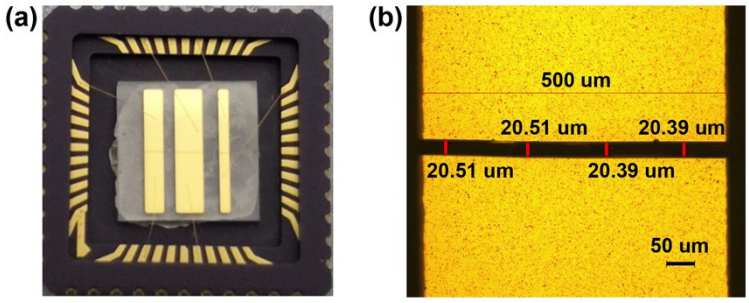

Fig. S6. (a) The photograph of the h-BN/sapphire photodetector and (b) the optical microscope image of Ti/Au electrodes. The distance between two adjacent Ti/Au electrodes is about 20 μm and the length is 500 μm.

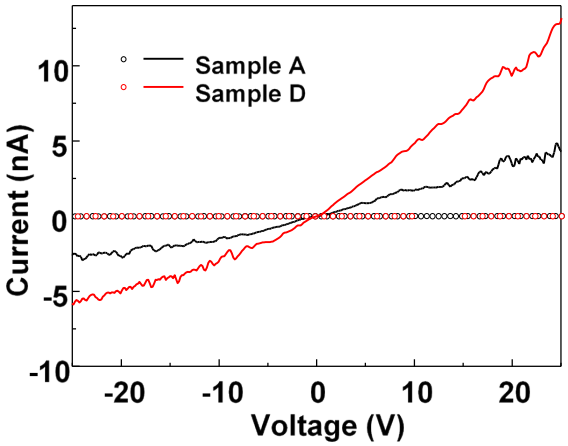

Fig. S7. The linear I-V curves of h-BN photodetectors based on sample A and sample D in the dark and under the 212 nm laser illumination.

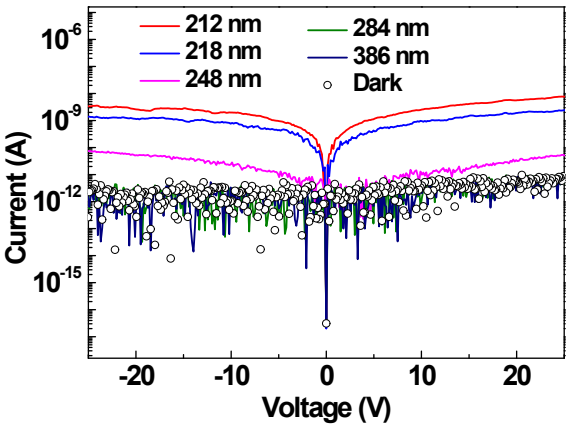

Fig. S8. The I-V curves of the h-BN photodetector under laser illumination with different wavelengths.

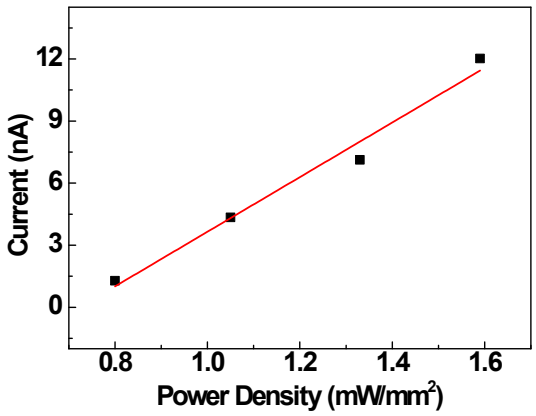

Fig. S9. Photocurrent as a function of light intensity under the 212 nm laser illumination at 25 V.

Table S1. For the DOS calculations of h-BN with different N vacancy concentrations, the supercell models with different total atomic number and N vacancies were constructed, in which N vacancies were located at the center or near the center of each supercell. The number of N vacancy and the total atomic number of supercells for the different N vacancy concentrations.

N vacancy concentration	number of N vacancy	total atomic number of supercells
0.42%	1	240
0.78%	1	128
2.34%	3	128
6.25%	8	128
10.00%	8	80
12.96%	14	108
15.63%	20	128
17.97%	23	128