# Supplementary Information: Nanoscale: Gate-tunable large spin polarization in few-layer black phosphorus based spintronic device

Liwen Zhang,[a,f] Jun Chen,[b,f] Xiaohong Zheng,[c,a] Bin Wang,[d,e,†] Lei Zhang,[a,f,*] Liantuan Xiao,[a,f] Suotang Jia,[a,f]

[a] *State Key Laboratory of Quantum Optics and Quantum Optics Devices, Institute of Laser Spectroscopy, Shanxi University, Taiyuan 030006, China*

[b] *Institute of Theoretical Physics, Shanxi University, Taiyuan 030006, China*

[c] *Key Laboratory of Materials Physics, Institute of Solid State Physics, Chinese Academy of Sciences, Hefei 230031, China*

[d] *College of Physics and Optoelectronic Engineering, Shenzhen Key Laboratory of Advanced Thin Films and Applications, Shenzhen University, Shenzhen, 518060, China*

[e] *Center for Quantum Computing, Peng Cheng Laboratory, Shenzhen 518060, China*

[f] *Collaborative Innovation Center of Extreme Optics, Shanxi University, Taiyuan 030006, China*

[*] *zhanglei@sxu.edu.cn*

[†] *binwang@szu.edu.cn*

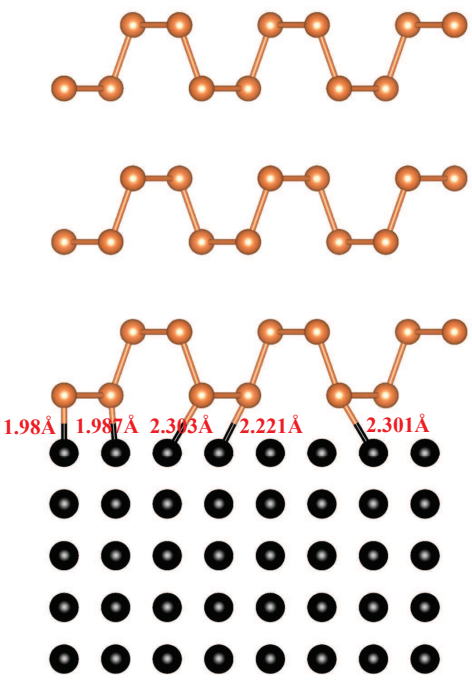


**Figure S1** Bond lengths between the trilayer BP and Ni electrode interface.

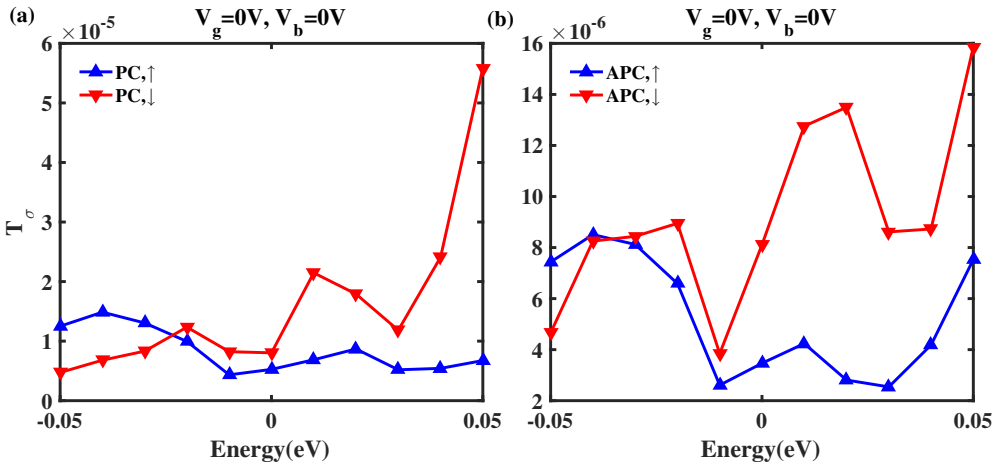


**Figure S2** The transmission coefficients $T_\sigma$ versus energy when $V_g$ = 0 V, $V_b$ = 0 V (a) in PC and (b) in APC.

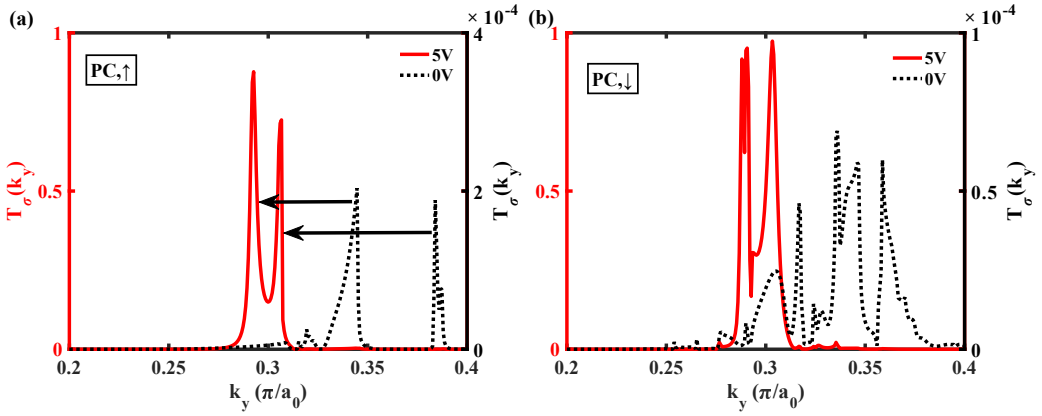


**Figure S3** The transmission coefficients $T_\sigma(k_y)$ versus transverse momentum $k_y$ when $V_g$ = 0, 5 V. (a) Spin up component in PC. (b) Spin down component in PC.

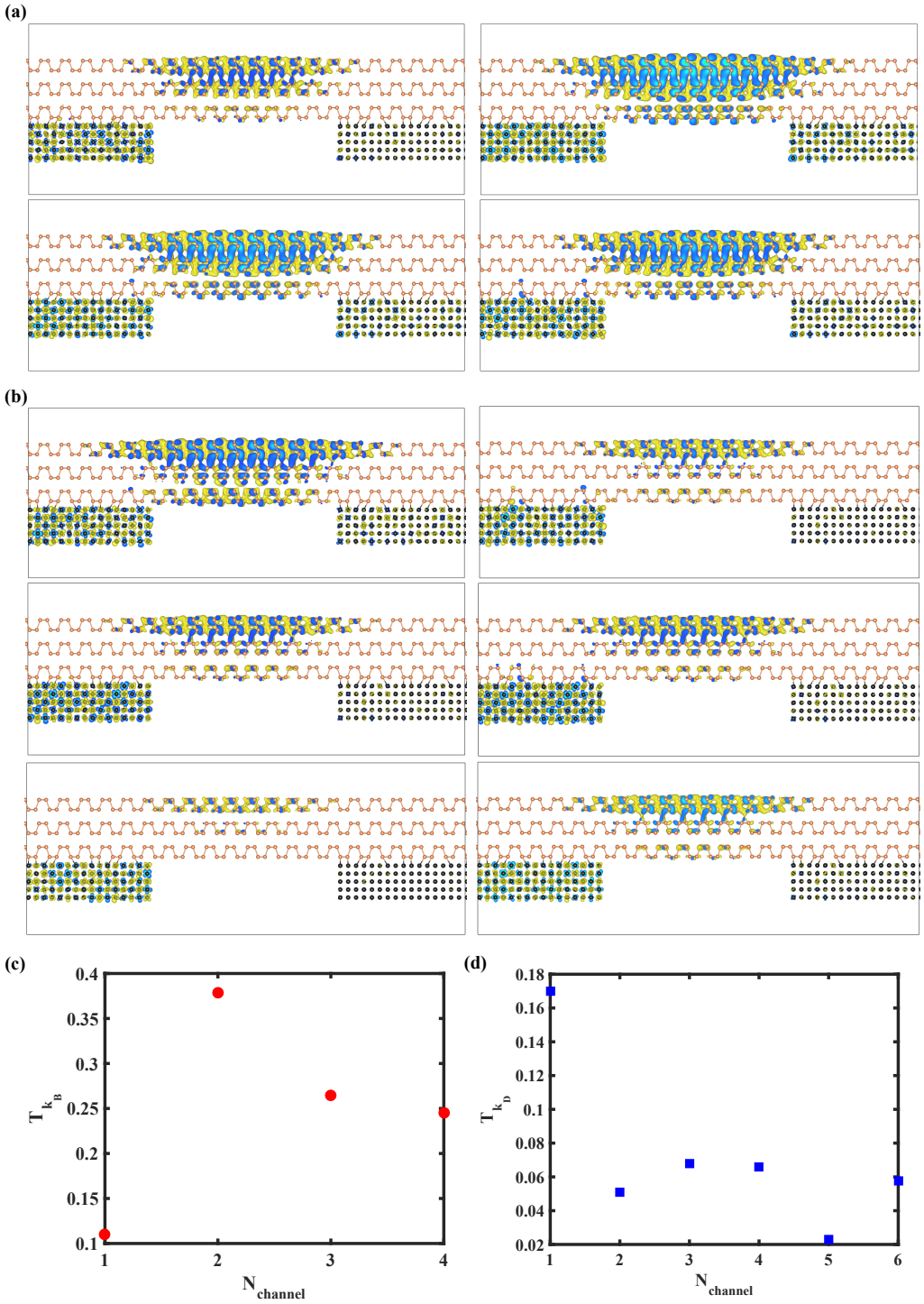


**Figure S4** (a) Isosurface plot of four scattering states of trilayer BP based spintronic device when $V_g = 5$V and momentum $k_y = k_B$ denoted as B in figure 5(b) in the main text. (b) Isosurface plot of six scattering states of trilayer BP based spintronic device when $V_g = 6$V and momentum $k_y = k_D$ denoted as D in figure 5(b) in the main text. (c) The transmission coefficient of the corresponding channel when momentum $k_y$ is equal to $k_B$. (d) The transmission coefficient of the corresponding channel when momentum $k_y$ is equal to $k_D$. Note that the isosurface value is fixed as 0.5 in (a,b).

**Table 1** The number of integration points $N_{real}$ in the real energy axis under different bias voltage.

| $V_b(V)$ | $N_{real}$ | $\Delta Q$ |
|---|---|---|
| -0.05 | 4 | 5.1177E-03 |
| -0.04 | 7 | 9.0088E-03 |
| -0.03 | 2 | 9.4702E-03 |
| -0.02 | 1 | 1.3602E-02 |
| -0.01 | 1 | 1.5195E-02 |
| 0.01 | 1 | 1.5585E-02 |
| 0.02 | 1 | 1.3291E-02 |
| 0.03 | 2 | 7.3376E-03 |
| 0.04 | 3 | 5.2070E-03 |
| 0.05 | 4 | 3.7321E-03 |