Interfacial electron modulation of MoS$_2$/black phosphorus heterostructure toward high-rate and high-energy density half/full sodium-ion batteries

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\textbf{Fig. S1} (a-c) Various magnification SEM patterns of BP basic material. (d) Raman spectrum of BP basic material.

\textbf{Fig. S2} The SEM pattern of MoS$_2$. 
Fig. S3 (a) XRD patterns of MoS$_2$, BP and MoS$_2$/BP composite.

Fig. S4 (a) Raman spectrum of the MoS$_2$/BP composite and (b) MoS$_2$ basic material.
Fig. S5 (a) XPS survey and the high-resolution XPS spectra of (b) Mo 3d, (c) S 2p and (d) P 2p of the MoS$_2$/BP composite.
Fig. S6 (a, b) Low- and high-magnification SEM patterns of the MoS$_2$/BP composite. (c, d) Various magnification TEM and HRTEM pictures of the MoS$_2$/BP composite.

Fig. S7 (a), (b) Other magnifications SEM patterns of the MoS$_2$/BP composite.
Fig. S8 Schematic diagram of the growth process of vertical MoS$_2$ nanosheets on BP: (a) nucleation, (b) diffusion, (c) forming arch structure, and (d) model of MoS$_2$/BP heterostructure.

Fig. S9. The nitrogen adsorption-desorption isotherms curve of MoS$_2$/BP composite.
Fig. S10 Nyquist plots of the MoS$_2$, BP and MoS$_2$/BP electrodes. The inset is corresponding equivalent circuit. $R_s$ is the ohmic resistance, $R_{ct}$ is the charge transfer resistance, CPE$_1$ is the constant phase element, and W is the Warburg impedance.

Fig. S11 The XRD pattern of the Na$_3$V$_2$(PO$_4$)$_2$O$_2$F cathode material.