2D-lamellar stacked $Na_3V_2(PO_4)_2F_3$@RuO_2 as a high-voltage, high-rate capability and long-term cycle cathode material for sodium ion batteries

Yu Zhang[a], Jiahong Xun[a], Kaiyuan Zhang[a], Bo Zhang[a], Huayun Xu[a*]

[a] *School of Chemistry and Chemical Engineering, Shandong University, Jinan 250100, P. R. China*

**Corresponding author:*

Huayun Xu

Tel.: +86 531 88366027

Fax: +86 531 88366028

E-mail: xuhuayun@sdu.edu.cn

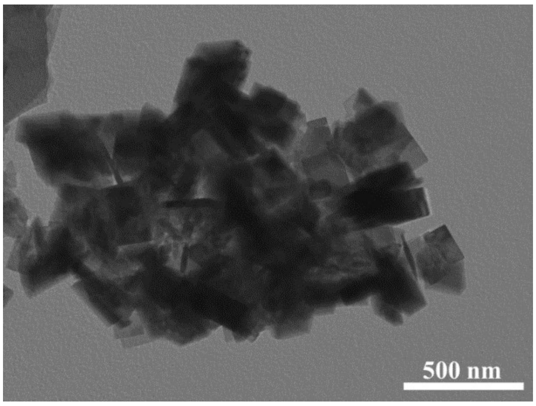

Fig. S1 TEM image of NVPF.

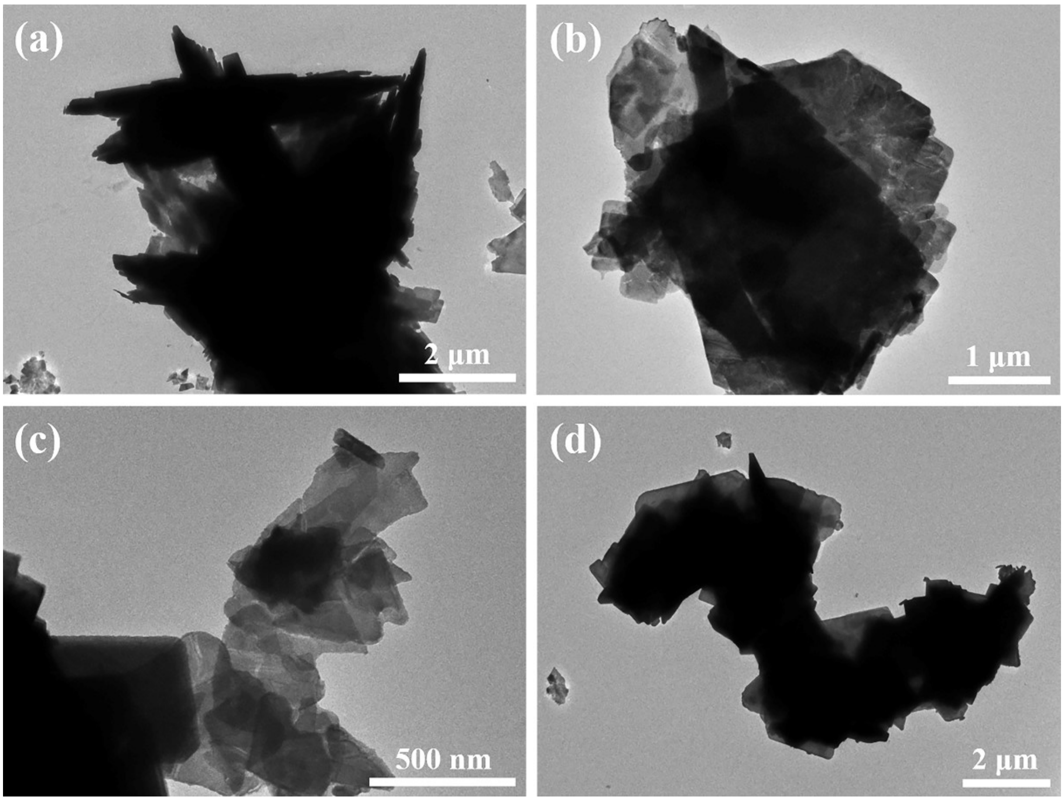

Fig. S2 TEM images of (a) NVPF@R1, (b) NVPF@R2, (c) NVPF@R3 and (d) NVPF@R4.

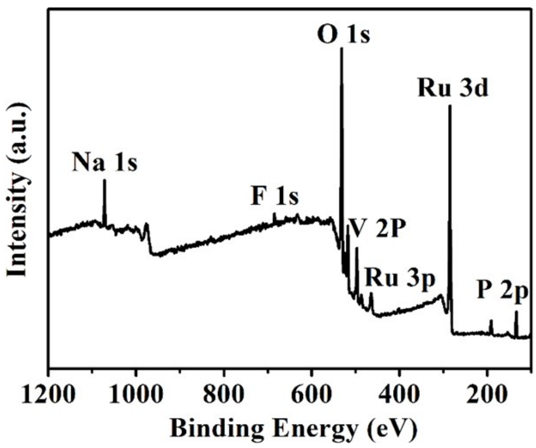

Fig. S3 Full XPS spectra of NVPF@R3.

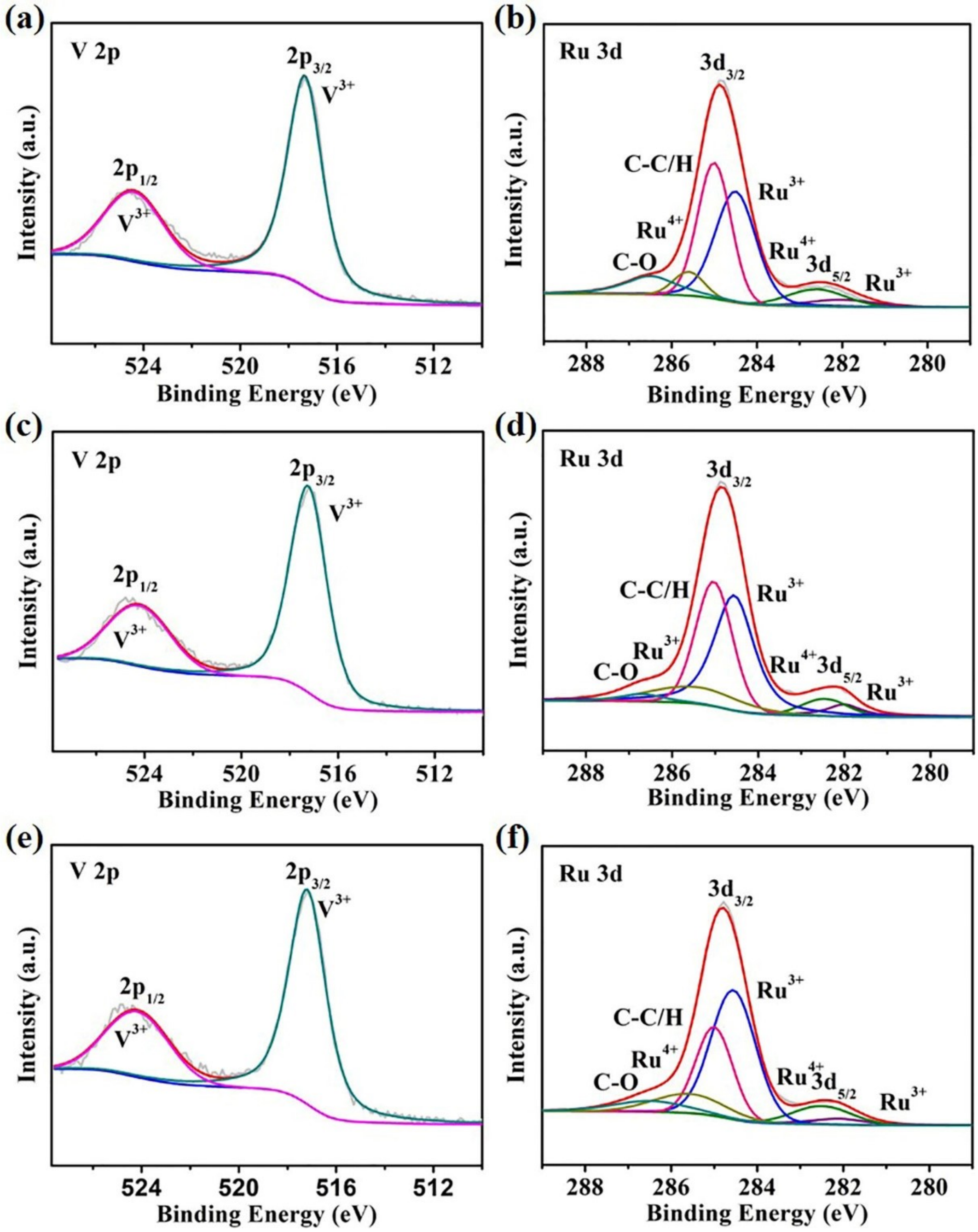

Fig. S4 XPS spectra of (a, c, e) V 2p and (b, d, f) Ru 3d of (a, b) NVPF@R1, (c, d) NVPF@R2 and (e, f) NVPF@R4.

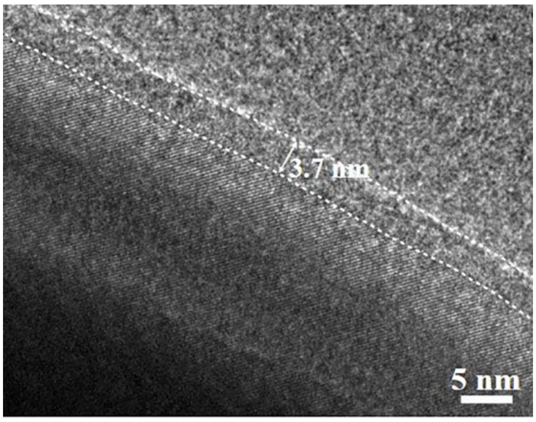

Fig. S5 HRTEM image of (a) NVPF@R1.

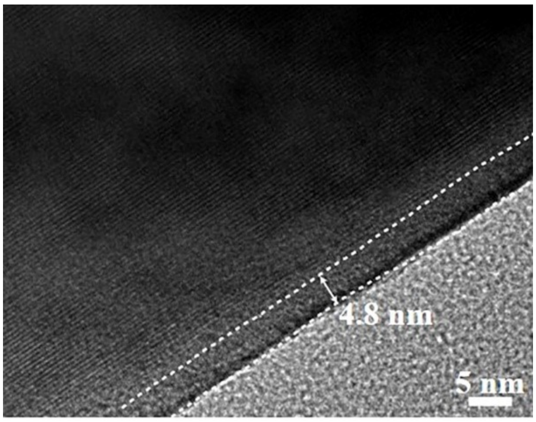

Fig. S6 HRTEM image of (a) NVPF@R2.

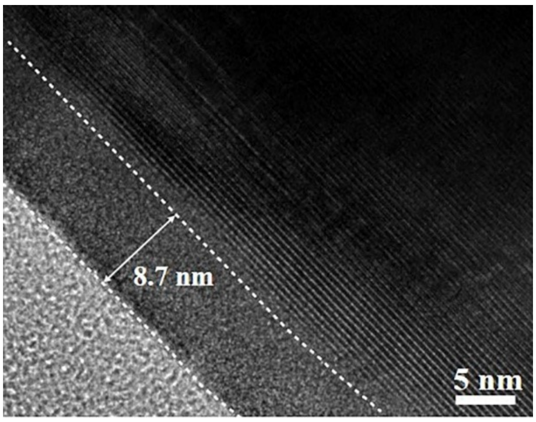

Fig. S7 HRTEM image of (a) NVPF@R4.

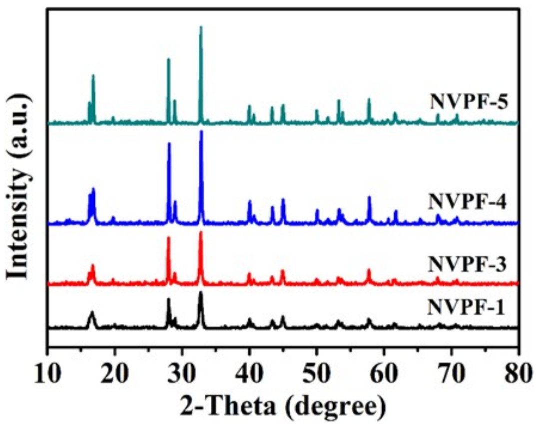

Fig. S8 XRD patterns of NVPF-1, NVPF-3, NVPF-4 and NVPF-5.

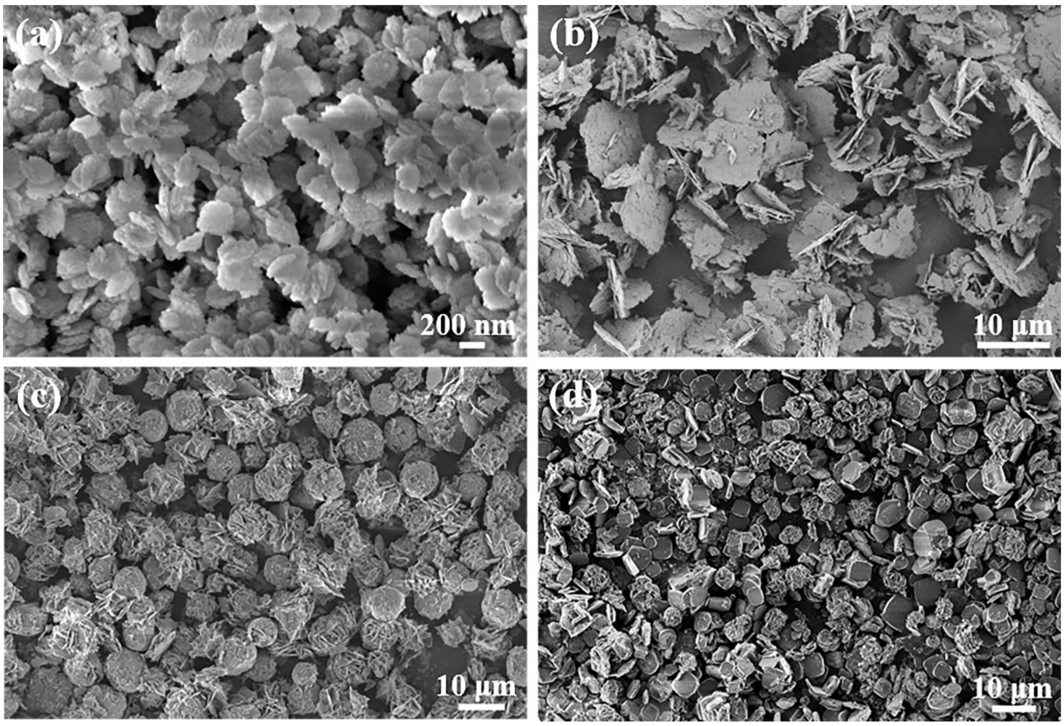

Fig. S9 Low magnification SEM images of (a) NVPF-1, (b) NVPF-3, (c) NVPF-4 and (d) NVPF-5.

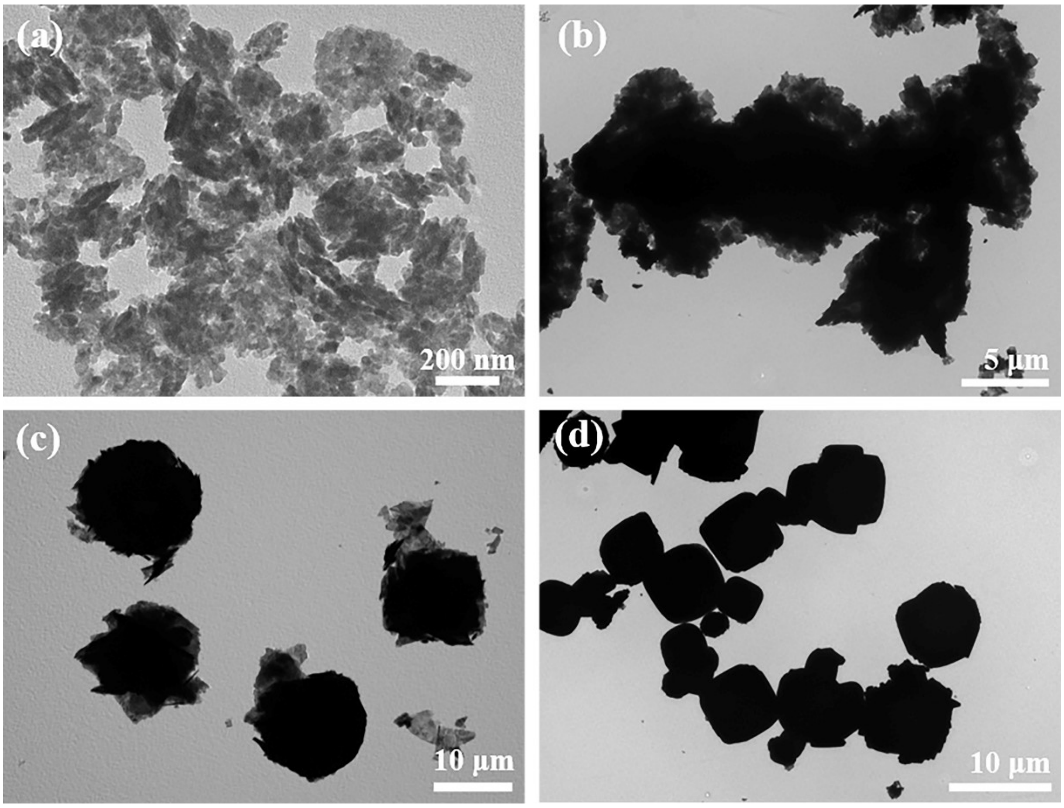

Fig. S10 TEM images of (a) NVPF-1, (b) NVPF-3, (c) NVPF-4 and (d) NVPF-5.

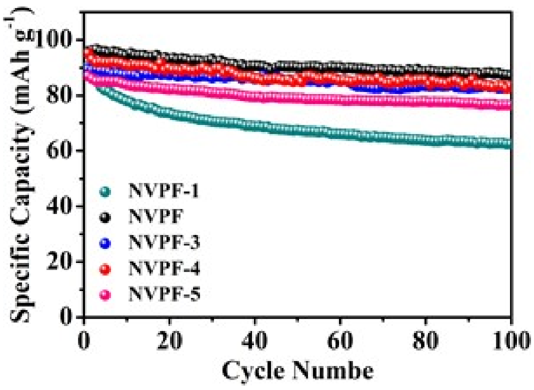

Fig. S11 Cycling performance of NVPF-1, NVPF, NVPF-3, NVPF-4 and NVPF-5 at 0.2 C.

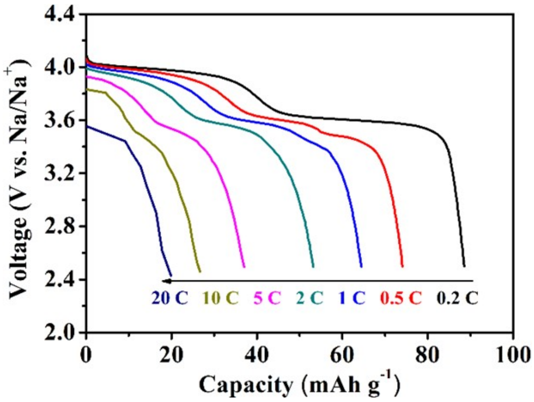

Fig. S12 Discharge curves at different rates (0.2 C, 0.5C, 1 C, 2 C, 5 C, 10 C, 20 C) of NVPF.

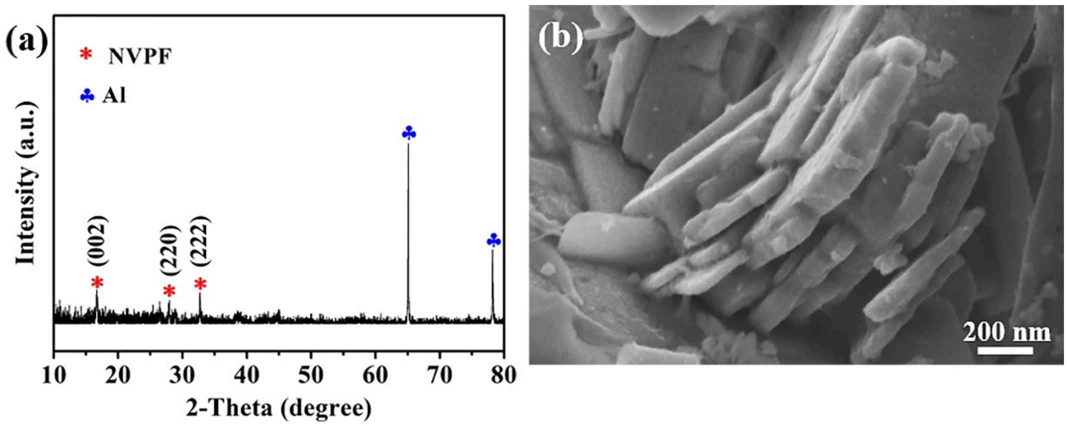

Fig. S13 (a) XRD and (b) SEM image of NVPF@R3 after cycling 1000 cycles at 20 C.

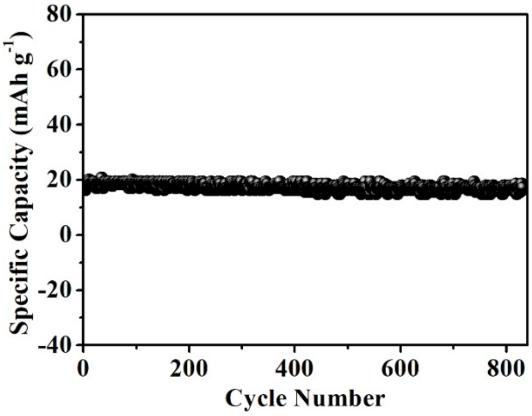

Fig. S14 Long-term cycling performance of NVPF at 20 C.

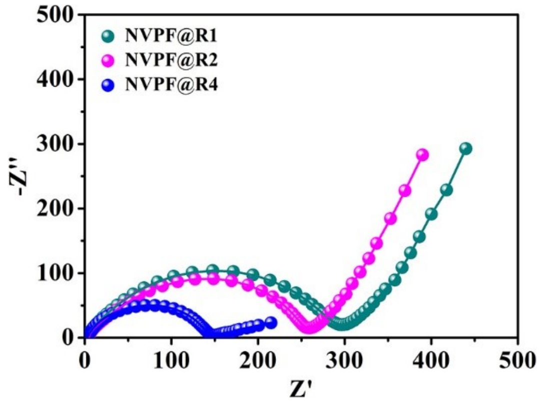

Fig. S15 Nyquist plots of NVPF@R1, NVPF@R2 and NVPF@R4.

Table S1 The electrochemical performance comparison of NVPF@R3 and other reported NVPF.

Samples	Voltage window (V)	Rate Capacity at 10 C (mAh g^{-1})	Plateau efficiency at 3.5 V (%)	Ref.
NVPF@R3	2.5-4.3	112.3	87.3	This work
NVPF@C	2.0-4.3	87.3	77.1	1
NVPF@C-3	2.0-4.3	89.2	68.6	2
$NV_{0.97}Fe_{0.03}PF/C$	2.5-4.3	85.0	77.3	3
$Na_3V_2(PO_4)_2F_3$@KB	2.0-4.5	126	70.6	4
$Na_3V_2(PO_4)_2F_3$–SWCNT-2	2.5-4.3	100.7	87	5
NVPF/C-PDPA	3.0-4.6	98	84.4	6
$Na_3V_2(PO_4)_2F_3$/C@RGO	2.5–4.3	90.6 at 6 C	84.3	7
$Na_3V_2(PO_4)_2F_3$@C/CNT	2.0-4.3	102	70.8	8
NVPF-$Ti_{0.1}^{2+}$	2.0-4.5	110	76	9
$Na_3V_{1.9}Y_{0.1}(PO_4)_3/C$	2.0-4.5	100	66.1	10

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