Supporting Information

Self-powered, ultra-broadband, and polarization-sensitive photodetectors based on 1D van der Waals layered material $Nb_2Pd_3Se_8$

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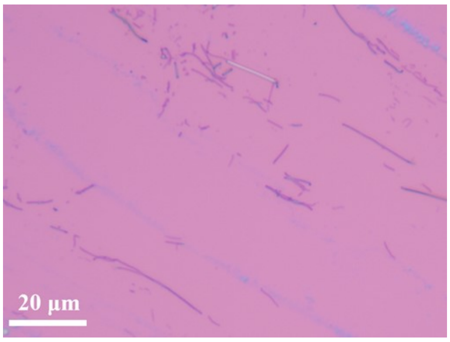

Figure S1. Optical image of the exfoliated $Nb_2Pd_3Se_8$ nanowires.

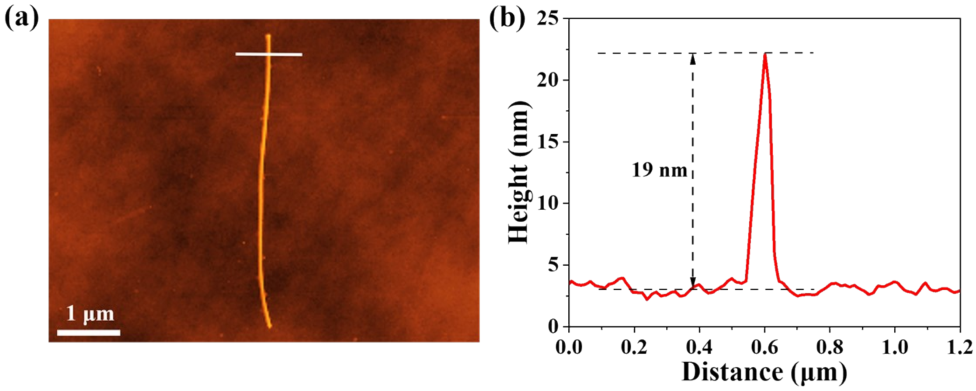

Figure S2. (a) AFM image of exfoliated $Nb_2Pd_3Se_8$ nanowire. b) Height profiles corresponding to the line in (a).

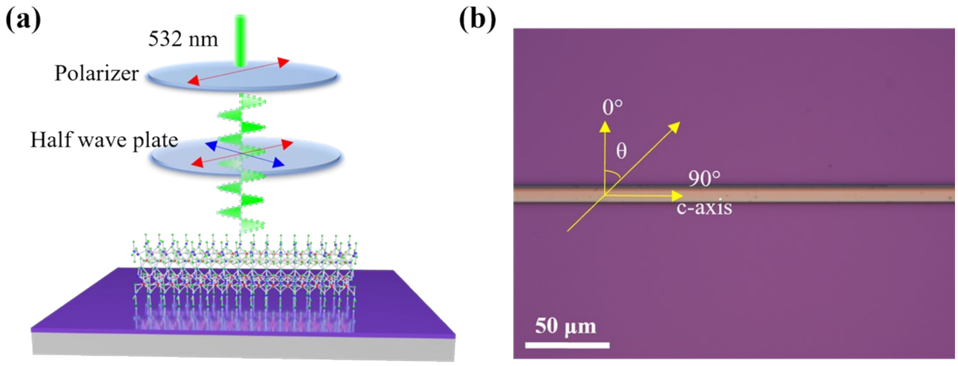

Figure S3. (a) Schematic diagram of the experimental setup for the polarized Raman test. (b) Optical image of the bulk $Nb_2Pd_3Se_8$.

From a semi-classical perspective, the Raman intensity of $Nb_2Pd_3Se_8$ can be identified by:

$$I \propto |e_i \cdot R_{..} \cdot e_s|^2 \qquad S(1)$$

where e_i and e_s are the unit polarization vectors of incident and scattered lasers, respectively, and R is the Raman tensor. The unit polarization vector is $e_i = (\cos\theta, 0, \sin\theta)$, where θ is the angle between incident light polarization and a axis direction of the $Nb_2Pd_3Se_8$. And $e_s = (\cos\theta, 0, \sin\theta)$ and $e_s = (-\sin\theta, 0, \cos\theta)$ correspond to e_s in parallel and perpendicular configurations, respectively. For an absorptive material, the

Raman tensor elements are complex values, with real and imaginary parts.[1] Bulk $Nb_2Pd_3Se_8$ belongs to the Pbam space group. Thus, the Raman tensor can be expressed as

$$R(A_g) = \begin{pmatrix} |a|e^{i\varphi_a} & 0 & 0 \\ 0 & |b|e^{i\varphi_b} & 0 \\ 0 & 0 & |c|e^{i\varphi_c} \end{pmatrix} \quad R(B_{1g}) = \begin{pmatrix} 0 & |d|e^{i\varphi_d} & 0 \\ |d|e^{i\varphi_d} & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

$$R(B_{2g}) = \begin{pmatrix} 0 & 0 & |e|e^{i\varphi_e} \\ 0 & 0 & 0 \\ |e|e^{i\varphi_e} & 0 & 0 \end{pmatrix} \quad R(B_{3g}) = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & |f|e^{i\varphi_f} \\ 0 & |f|e^{i\varphi_f} & 0 \end{pmatrix} \qquad S(2)$$

where φ_a, φ_b, φ_c, φ_d, φ_e, and φ_f are the corresponding phases of the Raman tensor elements.[2] Then, the Raman scattering intensities of different modes can further be expressed as

$$I(A_g, //) \propto |c|^2\left\{\left(sin^2\theta + \frac{|a|^2}{|c|^2}cos\varphi_{ca}cos^2\theta\right)^2 + \left(\frac{|a|}{|c|}sin\varphi_{ca}cos^2\theta\right)^2\right\} \qquad S(3)$$

$$I(B_{2g}, //) \propto |e|^2 sin^2 2\theta \qquad S(4)$$

where // represents parallel polarizations, and $\varphi_{ca} = \varphi_c - \varphi_a$ is the phase difference. It can be seen that the calculated curves fitted well with the experimental data in Figure 2f.

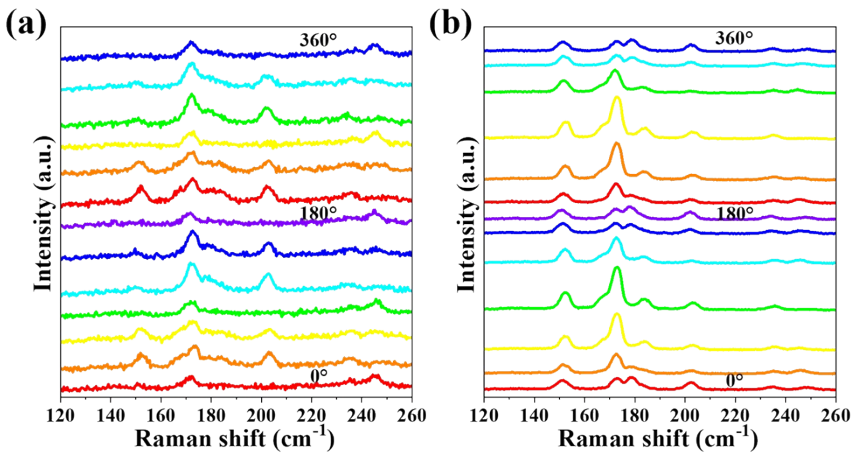

Figure S4. Angle-resolved polarized Raman spectra acquired in the (a) parallel configuration and (d) perpendicular configuration.

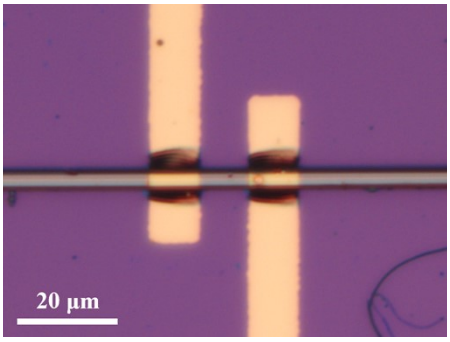

Figure S5. Optical image of the $Nb_2Pd_3Se_8$ device.

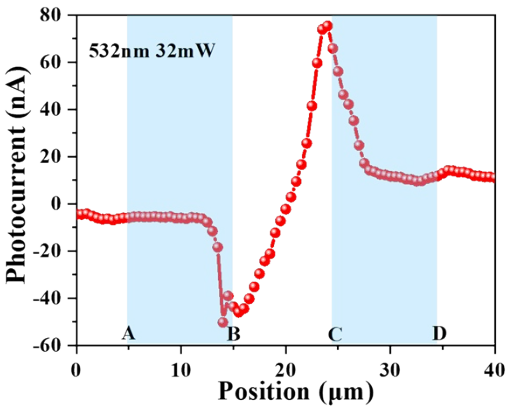

Figure S6. Photocurrent response of the $Nb_2Pd_3Se_8$ device along a line cut in Figure 4b. The blue portions represent the Au electrodes of the device.

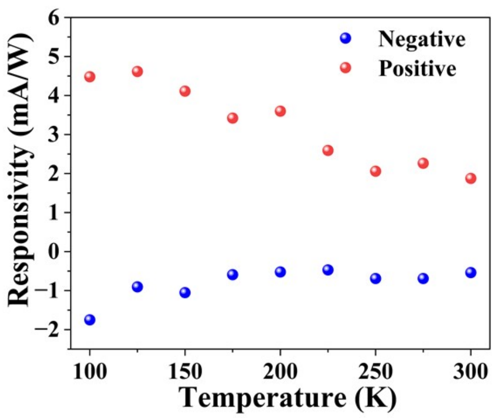

Figure S7. The responsivity of the $Nb_2Pd_3Se_8$ photodetector under different temperatures.

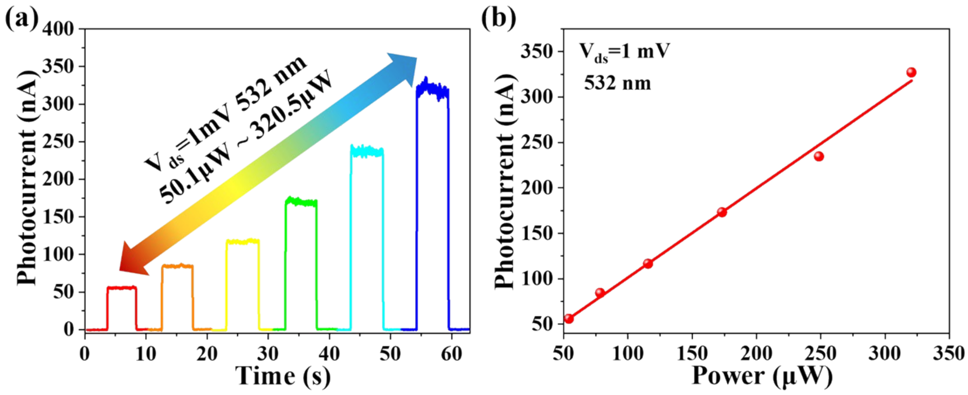

Figure S8. (a) Photoresponse of the $Nb_2Pd_3Se_8$ photodetector with a bias of 1 mA to different light intensities under 532 nm light illumination. (b) A good linear relationship between photoresponse and light intensities in the experimental range.

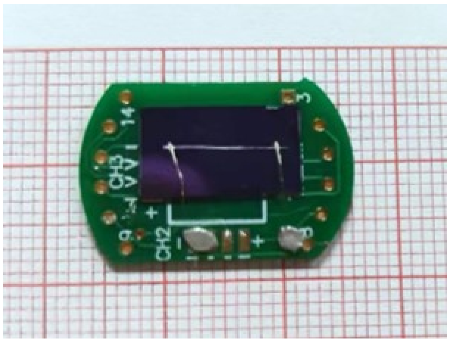

Figure S9. Optical image of the $Nb_2Pd_3Se_8$ device for broadband detection.

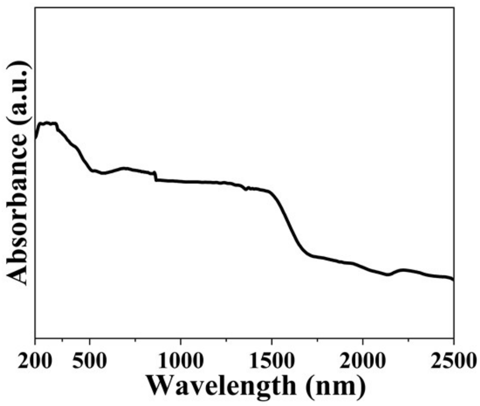

Figure S10. Absorption spectrum of the $Nb_2Pd_3Se_8$.

Table S1. Comparison of Photodetectors Reported in the Literature.

Materials	Responsivity	Response time	Polarization extinction ratio	Spectral Range (μm)	Ref.
$PtTe_2$	0.04 mA W^{-1}	34 μs	1.11 (633 nm)	0.532-4	[3]
$NdSb_2$	0.49 mA W^{-1}	15 μs	1.6 (532 nm)	0.532-4	[4]
$MoTe_2$	0.4 mA W^{-1}	43 μs	1.19 (633 nm)	0.532-10.6	[5]
$TaIrTe_4$	0.02 mA W^{-1}	27 μs	1.13 (633 nm)	0.532–10.6	[6]
Cd_3As_2	5.9 mA W^{-1}	6.9 ps	—	0.532-10.6	[7]
$Nb_2Pd_3Se_8$	2.74 mA W^{-1}	55 ms	1.42 (532 nm)	0.365-10.6	This work

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