Electronic Supplementary Information (ESI)

Enhanced device performances of WSe_2/MoS_2 van der Waals junction p-n diode by fluoropolymer encapsulation

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Supplementary Information 1

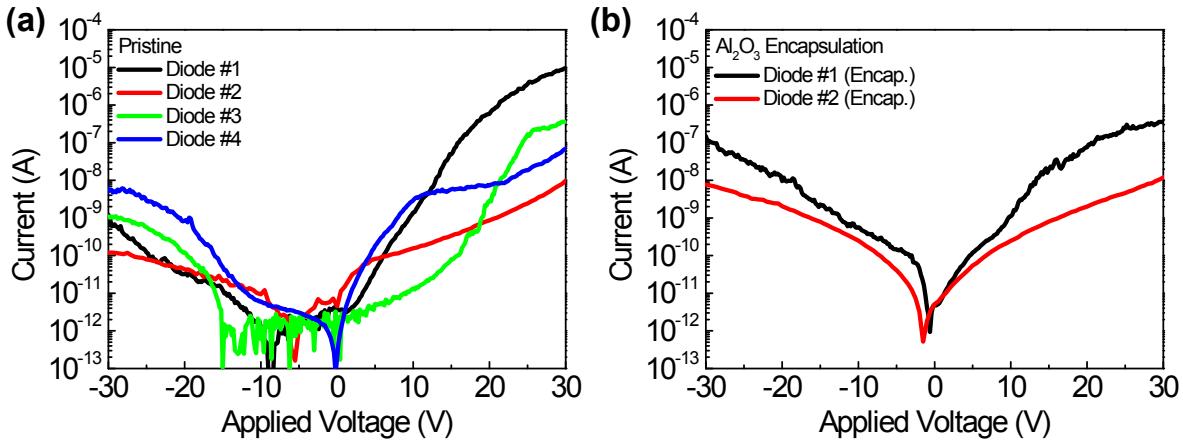

Fig. S1 The current-voltage curves of two sets of WSe_2/MoS_2 heterojunction p-n diode on SiO_2/p^+-Si. (a) Pristine 1, 2, 3, and 4 diodes show non-ideal bad I-V properties, and (b) the pristine diodes (1,2) gets more degraded with Al_2O_3 showing higher reverse current.

Supplementary Information 2

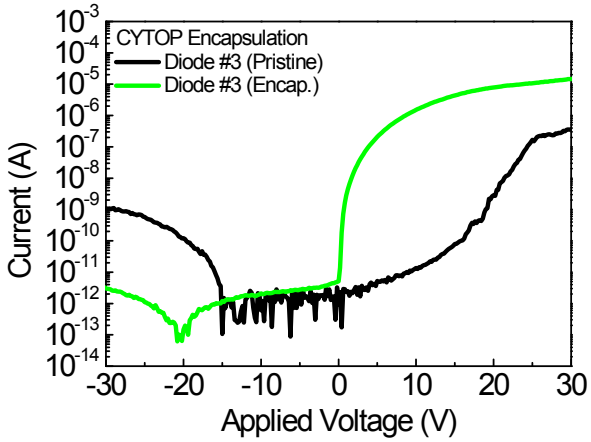

Fig. S2 The current-voltage curves of another set of WSe_2/MoS_2 heterojunction p-n diode on SiO_2/p^+-Si. We performed this measurement to see the reproducibility of the effects of CYTOP encapsulation on property enhancement.

Supplementary Information 3

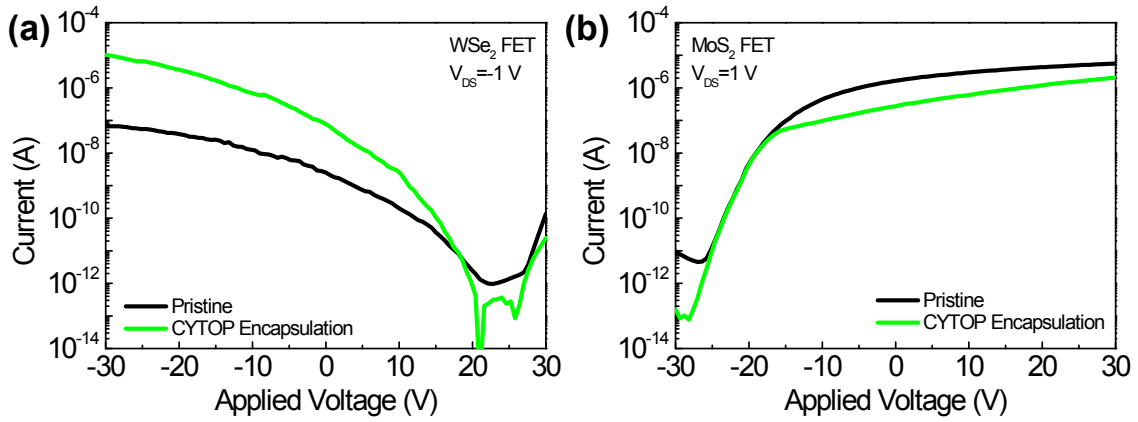

Fig. S3 The current-voltage curves of another back gate (a) p-WSe_2 and (b) n-MoS_2 FETs on SiO_2/p^+-Si. We performed this measurement to see the reproducibility of the effects of CYTOP encapsulation on property enhancement (hole current increase in WSe_2 but electron current decrease in MoS_2 channel).

Supplementary Information 4

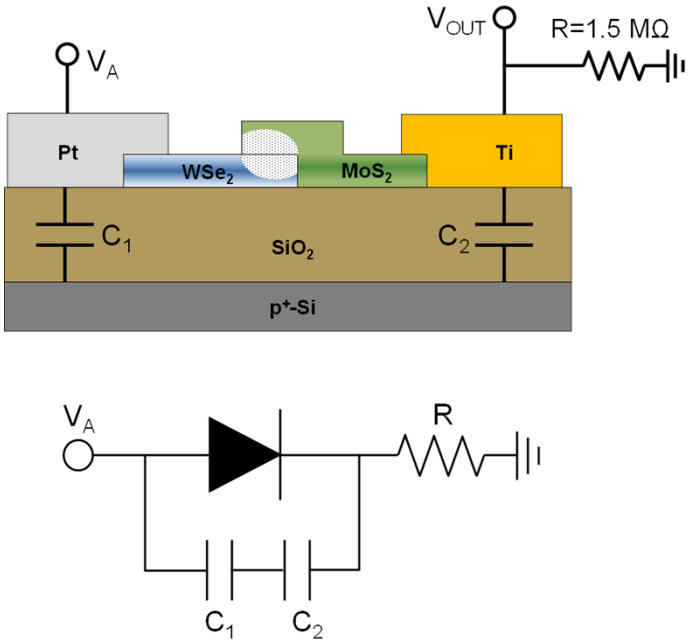

Fig. S4 Our p-n diode circuit in a schematic illustration (top) and an equivalent circuit diagram (bottom) where the parasitic capacitors (C_1 and C_2) are induced by the large overlapped area between electrodes (Pt, Ti) and heavily doped p^+-Si substrate. Thus these capacitors are connected parallel with our p-n diode and also connected with the external resistor in series. In the initial short moment of any fast switching, some displacement current can be caused through the C_1 and C_2 overriding the current through the diode. As a result, overshoot/undershoot behavior can be observed during the dynamics using V_A=±5 V.

Supplementary Information 5

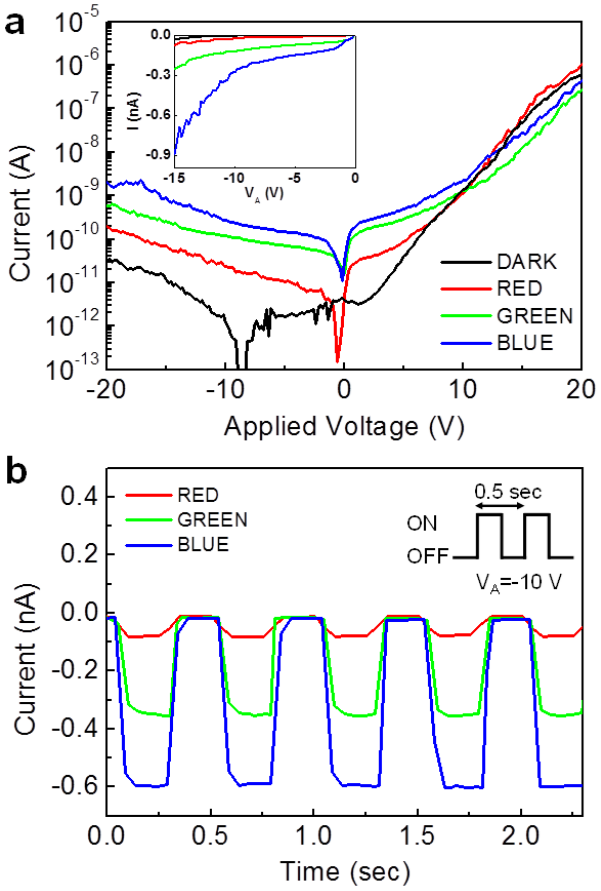

Fig. S5 (a) Photo-induced I-V curves obtained from a pristine heterojunction p-n diode under R, G, and B LED lights. (The inset shows linear scale photo I-V curves in reverse bias regime.) Time dependent photocurrent responses (I-t) were also obtained at a reverse bias of V_{IN}=-10 V, at light pulse frequencies of (b) 2 Hz. Response time was ~more than 60 ms (even at -10 V), which is three times slower than that of CYTOP-encapsulated device. This may indicate that the junction or surface trap density in CYTOP-encapsulated diode is much lower than that of pristine device as we discussed in the main text with Fig. 5 and 6.

Supplementary Information 6

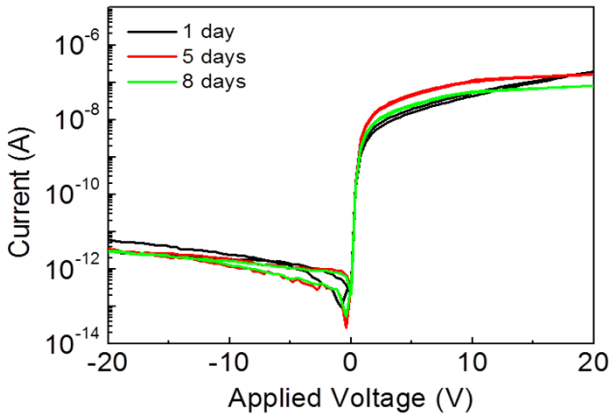

Fig. S6 Aging degradation of CYTOP-capped 2D p-n diode was not found for more than 8 days in air ambient of 40% relative humidity at room temperature, which indicates that our encapsulated diode is very stable in ambient.