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Bio-inspired Tactile Nociceptor Constructed by Integrating Wearable Sensing Paper and VO_2 Threshold Switching Memristor

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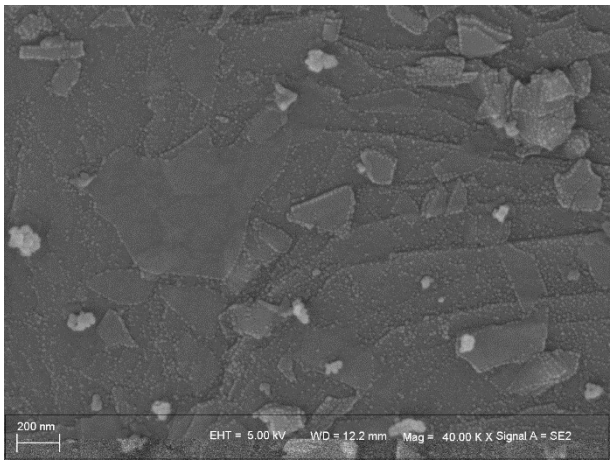

Figure S1. Low-magnification SEM image of the MXene flakes.

Figure S2. The physical picture of sensitive layer.

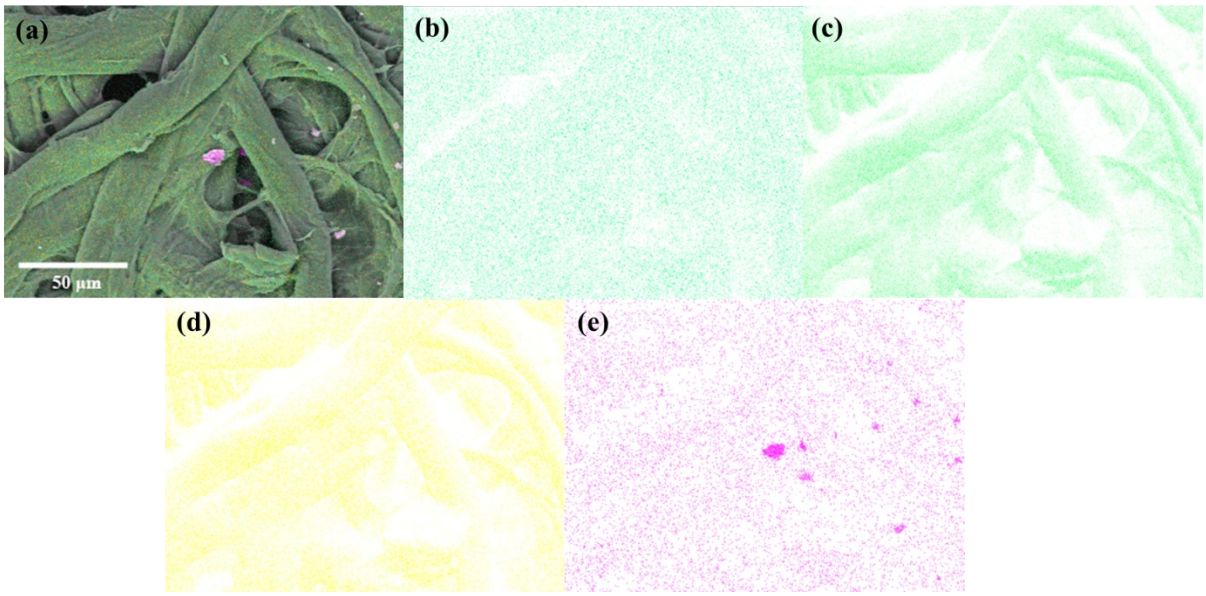

Figure S3. SEM-EDS analysis of the filter paper membrane impregnated by MXene/MWCNTs-hydrogel, showing the uniformly distributed elements of including (b) P, (c) O, (d) C and (e) Ti.

SEM-EDS analysis was adopted on the filter paper (impregnated by MXene/MWCNTs-hydrogel) membrane as shown in Figure S3. We chose phosphorus (P) element PVA/phosphoric acid hydrogel while titanium (Ti) for the indicator of Ti_3C_2 MXene nanosheets, respectively. Both CNTs and filter paper contain carbon (C) element and are evenly distributed. It is indicating that the conductive filler of MXene nanosheets and MWCNTs are successfully mixed with filter paper with the assistance of PVA hydrogel.

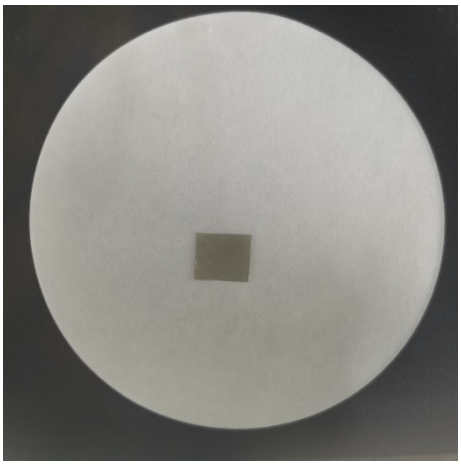

Figure S4. The physical picture of AgNWs electrode.

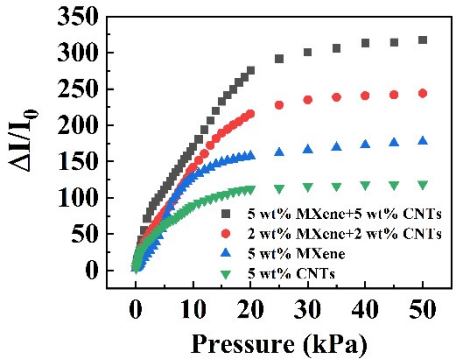

Figure S5. Relative current change ($\Delta I/I_0$) of the E-skins with different concentrations of MXene and MWCNTs filling.

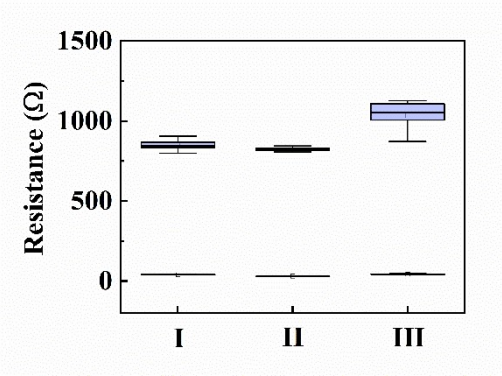

Figure S6. Variations of the resistance parameters for three W/VO_2/Pt memristor samples.

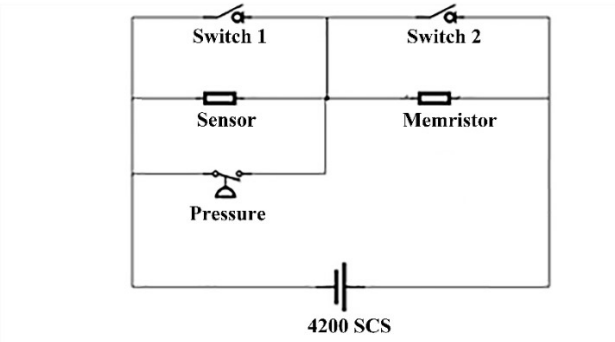

Figure S7. The circuit schematic of the integrated system.

In dynamic sensing testing, the E-skin and the memristor are connected in series using copper wire, and the two switches facilitate testing of individual or integrated devices, as shown in Figure S7. The semiconductor parameter analyzer (4200SCS, Keithley) is used as the voltage source, which provided a constant voltage to the system. By applying pressure, the resistance and partial voltage of E-skin are changed. Correspondingly, the change in pressure external to the E-skin affects the magnitude of the voltage on the memristor. When the voltage reaches the threshold, the resistance-state of the memristor will transform. Thus, the E-skin simulates the biological skin to

sense external pressure and generate electrical signals, while the threshold switching memristor simulates the biological nociceptor to receive and process the receptor signals.