Electronic Supplementary Material (ESI) for Nanoscale Advances.


**Surface Group Modified Mxene Nano-flakes doping of Tungsten Disulfide Monolayer**

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## 1. Characterization of Mxene

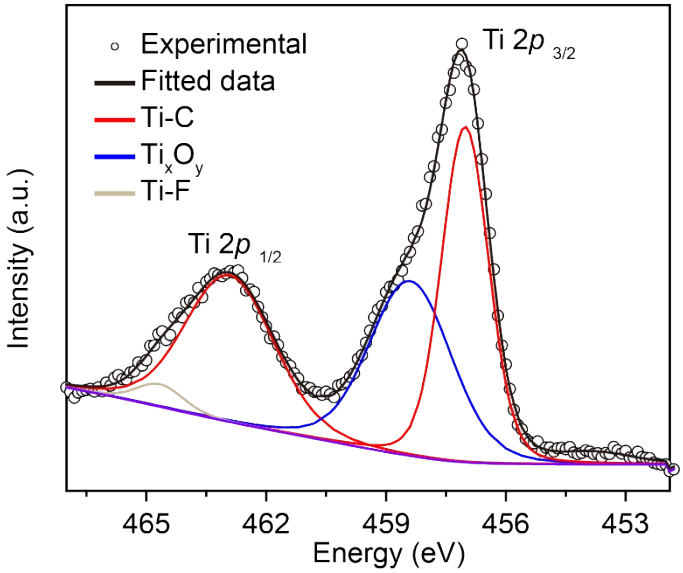


**Figure S1.** High-resolution X-ray photoelectron spectroscopy (XPS) spectra of F-$Ti_3C_2T_x$ nano-flakes in Ti 2p region and its corresponding deconvoluted components.

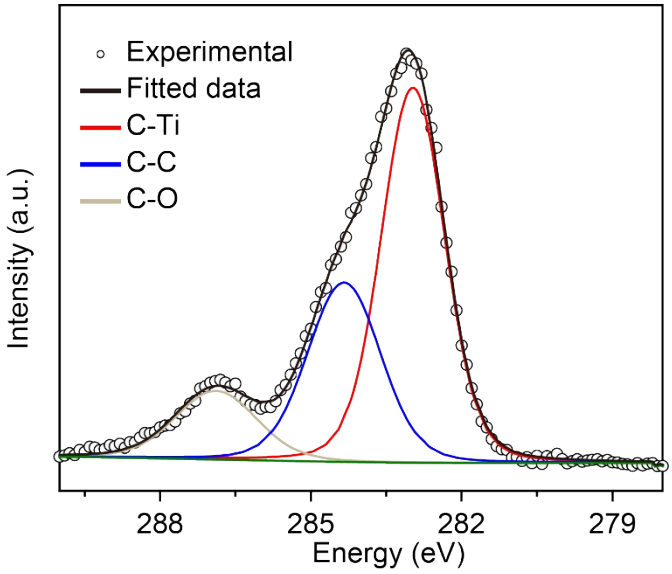


**Figure S2.** High-resolution X-ray photoelectron spectroscopy (XPS) spectra of F-$Ti_3C_2T_x$ nano-flakes in C 1s region and its corresponding deconvoluted components.

## 2. Characterization of monolayer $WS_2$

The photoluminescence (PL) spectra of monolayer $WS_2$ on $SiO_2$/Si substrate were conducted through a WITec alpha 300 R system with an excitation wavelength of 532 nm at room temperature. In order to avoid heating and optical doping effect, the power of laser was kept as low as 10 μW for the room temperature PL measurement.

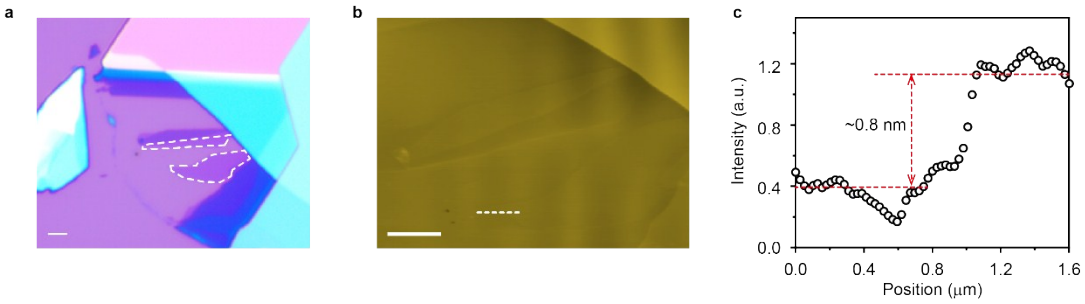


**Figure S3**. (**a**) Optical image, (**b**) AFM image of a $WS_2$ flake on $SiO_2$/Si substrate measured at room temperature. (**d**) The AFM height measured along the dotted line in (**b**). The scale bar in (**a**) and (**b**) is 2 μm, respectively.

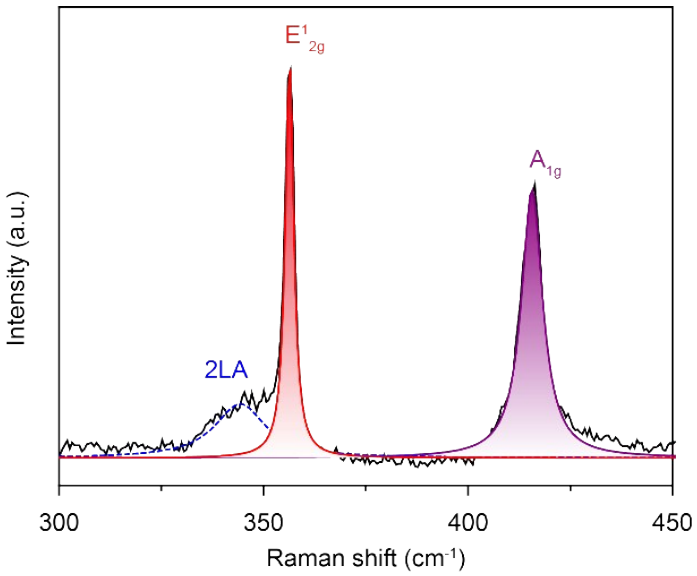


**Figure S4**. Raman spectrum of a $WS_2$ flake on $SiO_2$/Si substrate measured at room temperature.

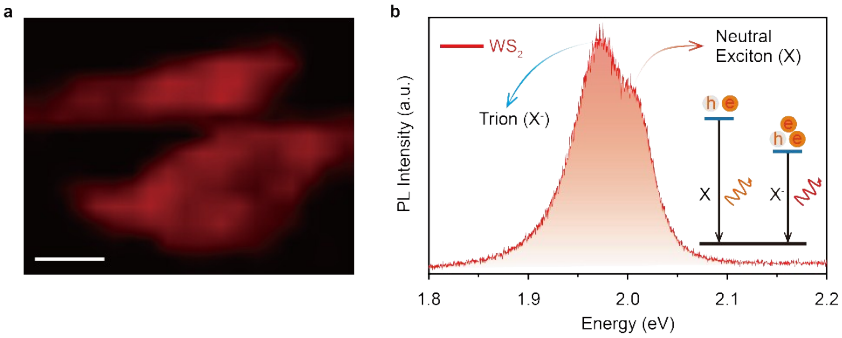


**Figure S5**. (**a**) PL mapping and (**b**) the corresponding PL spectrum of monolayer $WS_2$ excited by 523 nm laser. Inset: schematic drawing of the neutral exciton (X) and negative trion ($X^-$). The scale bar in (**a**) is 2 μm.

**Table S1**. A brief summary of the PL enhancement in atomically thin transition metal dichalcogenides (TMDCs).[1-6]

| TMDCs | Dopant | PL enhancement factor [a] | References |
|---|---|---|---|
| **$WS_2$** | F4TCNQ | ~2.3 | S1 |
| **$WS_2$** | fluorine plasma | ~4.2 | S2 |
| **$WS_2$** | choline plasma | ~3.0 | S3 |
| **$MoS_2$** | F4TCNQ | ~3.2 | S4 |
| **$MoS_2$** | TCNQ | ~2.9 | S4 |
| **$MoS_2$** | graphene | ~2.0 | S5 |
| **$MoS_2$** | gate voltage | ~2.8 | S6 |
| **$WS_2$** | HATCN | ~10 | S7 |
| **$WS_2$** | Mxene | ~5 | This work |

[a]The PL enhancement factor is defined as the ratio of the final integrated intensity of modified TMDCs to the integrated intensity of pristine TMDCs.

**References:**

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