Supporting information

Air-Stable MXene/GaAs Heterojunction Solar Cells with a High Initial Efficiency of 9.69%

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Figures:

Figure S1. J-V curves of devices with and without InGaP BSF layer under AM 1.5 illumination. The concentration of Ti$_3$C$_2$T$_X$ colloidal solution used here is 0.05mg/mL.
**Figure S2.** $J-V$ curve of device without Ti$_3$C$_2$T$_X$ under AM 1.5 illumination.

**Figure S3.** $I-V$ characteristics of Ti$_3$C$_2$T$_X$ films prepared with various concentrations of Ti$_3$C$_2$T$_X$ solution.
**Figure S4.** $J-V$ curves of devices fabricated by Ti$_3$C$_2$T$_X$ colloidal solution with various concentrations under dark condition.

**Figure S5.** $J-V$ curves of devices fabricated with 6 and 3$\mu$L Ti$_3$C$_2$T$_X$ colloidal solution under AM 1.5 illumination.
Figure S6. Ga 3d XPS spectra of MXene coated on GaAs substrate. Ga–As bond and Ga-O band is located at 18.96 eV and 20.15 eV, respectively. The original proportion of Ga-O that represents the oxidation of GaAs surface is 15.25%

Figure S7. Ti 2p XPS spectra of as-prepared Ti$_3$C$_2$T$_x$ films
Figure S8. SEM image of 2% HCl treated Ti$_3$C$_2$Tx films

Figure S9. Raman spectra of TSFA and HAuCl$_4$ treated Ti$_3$C$_2$Tx films coated on Si substrate. The Raman mode at 520 cm$^{-1}$ correspond to the Si substrate.
Figure S10. SEM images (a and d), Ti 2p XPS spectra (b and e) and Ga 3d XPS spectra (c and f) of 20mM TSFA and 5mM HAuCl₄ treated Ti₃C₂Tx films. The proportion of TiO₂ and Ga-O is increased to 10.13% and 29.08% after 20mM TSFA treated. For the HAuCl₄ treated devices, the proportion of TiO₂ and Ga-O is increased to 9.68% and 23.08%. g) Au 4f XPS spectra of 5mM HAuCl₄ treated Ti₃C₂Tx films. J-V curves of devices with and without h) 20mM TSFA and i)5mM HAuCl₄ treated.

Figure S11. J-V curves of Ti₃C₂Tx/GaAs solar cells with ZnS/MgF₂ composite coating.
Figure S12. *J-V* curves of Ti$_3$C$_2$T$_X$/GaAs solar cells with HCl doping and ZnS/MgF$_2$ composite coating.