

High performance $\text{TiO}_2@\text{Ti}_3\text{C}_2\text{T}_x$ MXene water vapor sensing material for diagnosing early SGTR accidents in nuclear power plants

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Fig. S1. Tyndall effect diagram of $\text{Ti}_3\text{C}_2\text{T}_x$ dispersions.

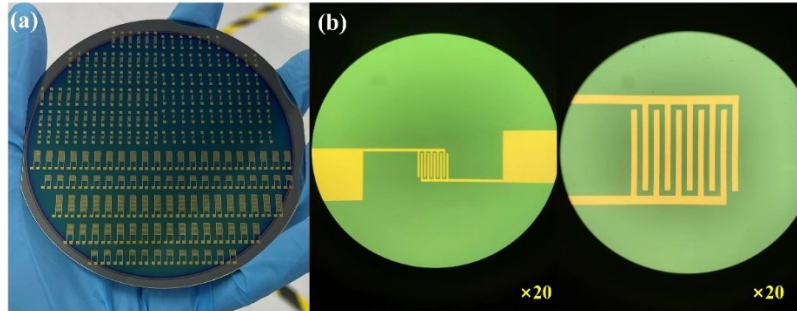


Fig. S2. (a) Photo of wafer with different finger electrode structures; (b) Photographs of interdigital gold electrodes (20x magnification under microscope).

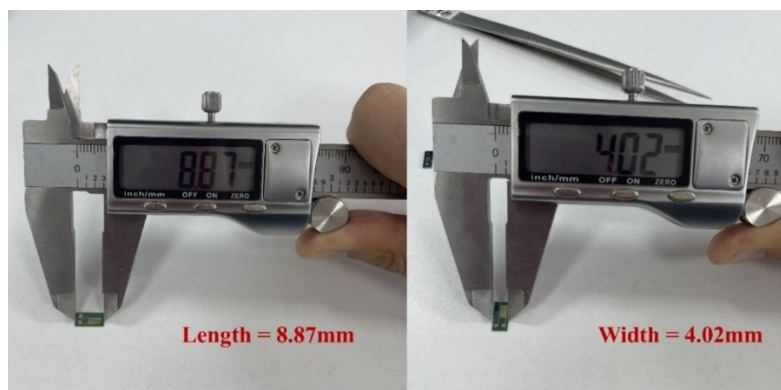


Fig. S3. The maximum size of the chip is: $8.87 \times 4.02 \times 1.05$ mm (Chip thickness is the total thickness of the wafer and superstructure).

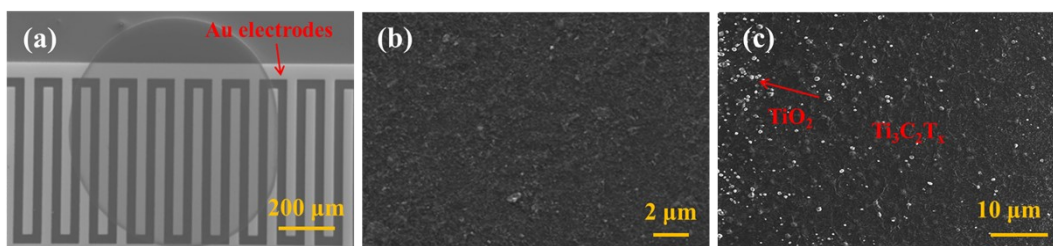


Fig. S4. (a) Overall SEM image of dripping onto the cross fingers. (b) SEM images of the $\text{TiO}_2@\text{Ti}_3\text{C}_2\text{T}_x$ gas sensor. (It should be noted that the gold interdigital electrodes cannot be seen due to the coverage of the dense TiO_2 nanoparticles). (c) $\text{TiO}_2@\text{Ti}_3\text{C}_2\text{T}_x$ surface SEM image.

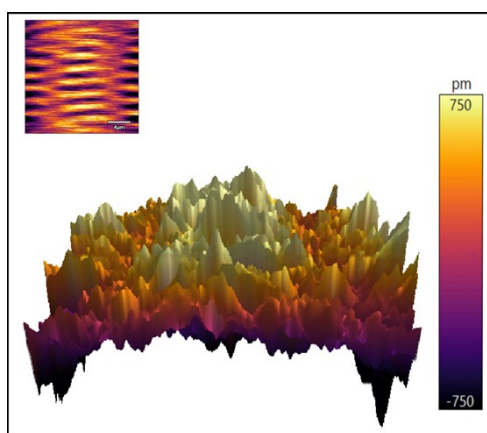


Fig. S5. AFM image of roughness.

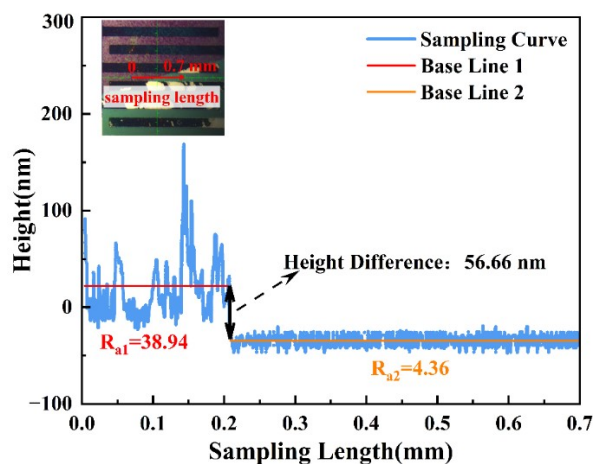


Fig. S6. Measurement of $\text{TiO}_2@\text{Ti}_3\text{C}_2\text{T}_x$ film thickness using a stepper probe.

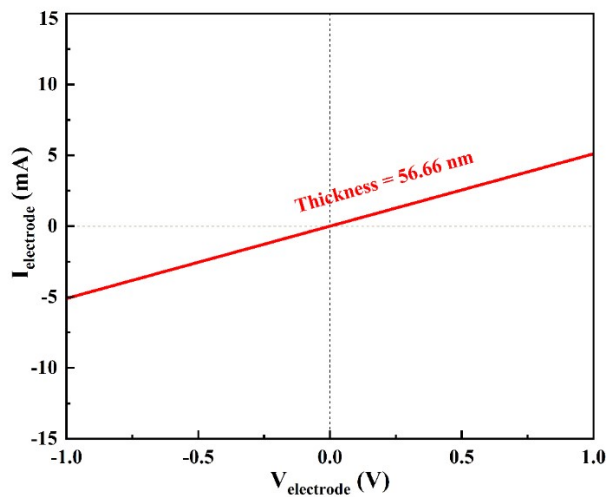


Fig. S7. I–V curves directly measured on the $\text{TiO}_2@\text{Ti}_3\text{C}_2\text{T}_x$ film sensor via a two-terminal method.

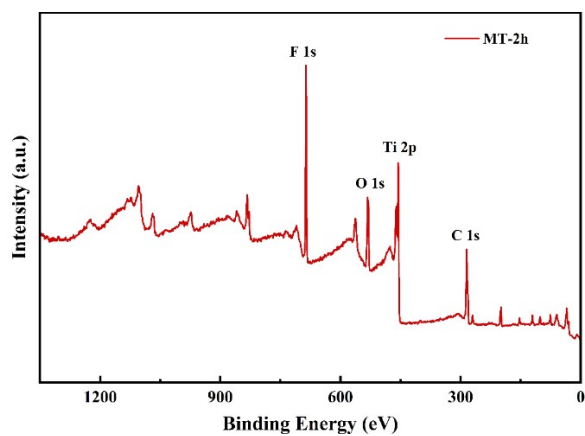


Fig. S8. Full XPS spectrum of MT-2h

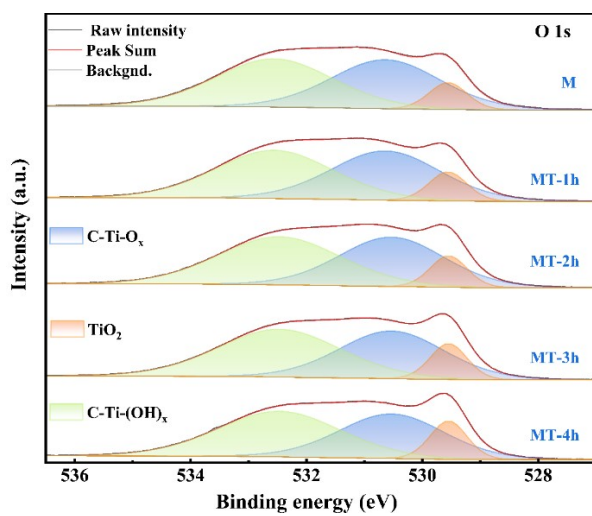


Fig. S9. The O 1s XPS spectra of M, MT-1h, MT-2h, MT-3h and MT-4h.

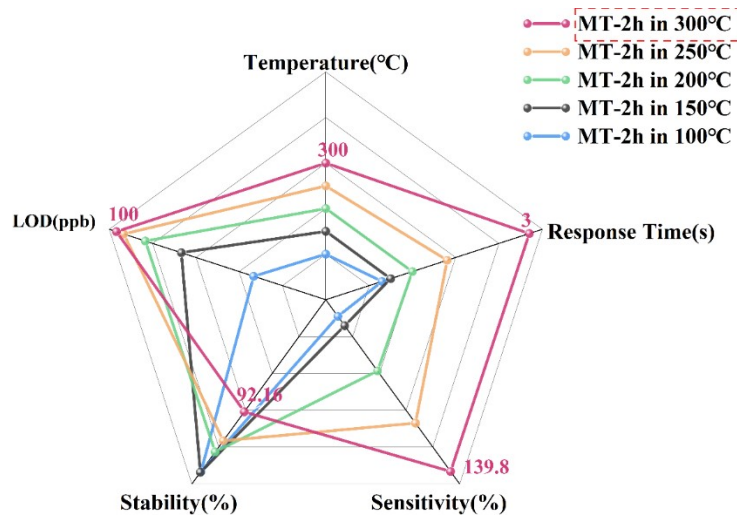


Fig. S10. Comparison of the individual response performance of the devices at different operating temperatures.

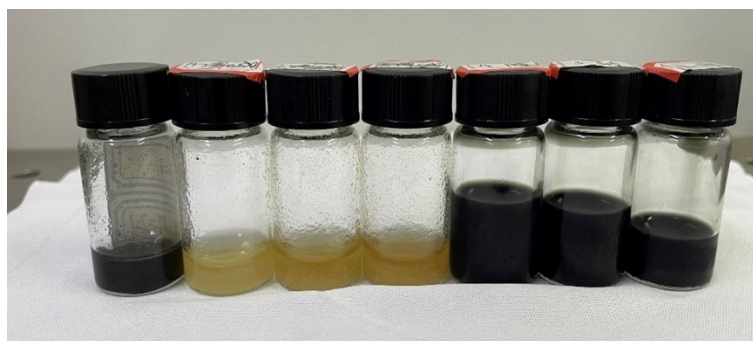


Fig. S11. Photograph of $\text{Ti}_3\text{C}_2\text{T}_x$ after 2 months of being stored in an aqueous dispersion (Low-concentration dispersion appeared light yellow, indicating serious oxidation; high-concentration dispersion appeared dark green, indicating slight oxidation).

Table S1. Comparison of MXene-based gas sensor performance

Materials	Gas	Conc.	t_1^a	t_2^b	T (°C)	Ref.
Ti ₃ C ₂ T _x	Organic Vapors ^c	100 ppm	300s	600s	25°C	[1]
Ti ₃ C ₂ T _x / TiO ₂	Organic Vapors ^d	100 ppm	~240s	~300s	25°C	[2]
Mxene / MWCNT	Water vapor	50%RH	28s	66s	~25°C ^e	[3]
V ₂ CT _x	Hydrogen	2ppm	120s	420s	23°C	[4]
	Methane	25ppm	480s	330s		
Ti ₃ C ₂ T _x / SnO ₂	Ammonia	500 ppm	109s	342s	25°C	[5]
CuO /Ti ₃ C ₂ T _x	Toluene	50 ppm	270s	10s	250°C	[6]
MT-2h	Water vapor	100 ppm	3s	41s	300°C	this work

References

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^a The t_1 indicating the response time of the sensor.

^b The t_2 indicating the recovery time of the sensor.

^c Indicating three organic gases: Acetone, Ethanol and Ammonia.

^d Indicating four organic gases: Acetone, Ethanol, Ammonia and Methanol.

^e The ~ indicating the estimate, which is not directly provided in the original text, was obtained by the author through the test charts.

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