Supplementary Information

Preparation of $Ti_3C_2T_x$ MXene nanosheets

MXene ($Ti_3C_2T_x$) nanosheets were obtained by selectively etching the Ti_3AlC_2 with LiF/HCl solution as described in previous publications. Typically, 2.0 g LiF and 40 mL 9 M HCl solution were mixed in a Teflon beaker with continually stirring to ensure the dissolution of LiF. Then, 2.0 g Ti_3AlC_2 powder was slowly added into the above mixture and stirred gently at 35 °C for 24 h to the etching of Al. The prepared suspension was repeatedly washed with deionized water through centrifugation at 3500 rpm until the pH value of supernatant was above 6. After that, the MXene sediment was dispersed in deionized water through ice-bath ultrasonication for 60 min to exfoliate the MXene flakes. Finally, a dark green homogeneous MXene nanosheets dispersion liquid was acquired by centrifugation at 3500 rpm for 1 h. The monolayer $Ti_3C_2T_x$ MXene is obtained after vacuum freeze-drying.

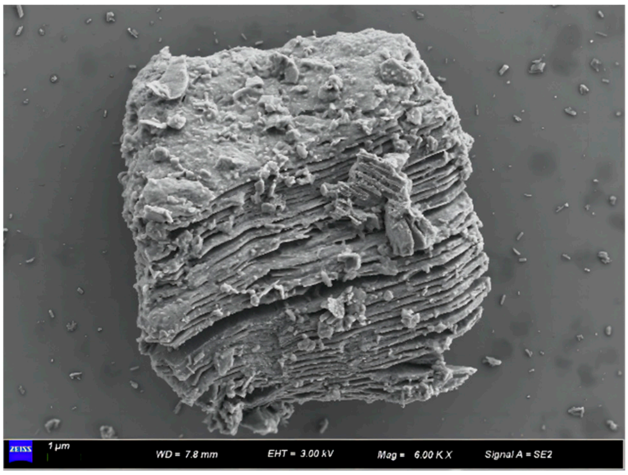

Figure S1. SEM images of Ti_3AlC_2 MAX with loose accordion-like structure.

Table S1. Composition ratio design of $Ti_3C_2T_x$ MXene/NR

Group	Pure NR（g）	$Ti_3C_2T_x$ MXene suspension dosage（ml）	Content of $Ti_3C_2T_x$ MXene（wt%）
1	166.67	0	0
2	165.83	25	0.5
3	165.00	50	1.0
4	163.00	150	3.0

Table S2. Test Prescription

MNx (g)	ZnO（g）	SA（g）	DM（g）	D（g）	CZ（g）	M（g）	S（g）
100	5.0	2.0	0.8	0.2	0.3	0.5	1.5

SA: stearic acid,
CZ: N-Cyclohexyl-2- benzothiazolesulfenamide，
DM: N,N- Dimethylaminoethyl Methacrylate,
D: D-Tartaric acid,
M: 2-Mercaptobenzothiazole.

We have considered the further controls and the specific improvements, which can regard the methodology. We believe that the dispersion of rubber additives could be intruded in latex mixing process rather than additional mechanical mixing process to shorten the synthetic period of $Ti_3C_2T_x$ MXene/NR composites.

Optimization plan:

Control factor 1: Uniform dispersion of rubber additives.

Optimization mode considered: rubber additives should be added in NR latex after emulsification rather than direct addition.

Control factor 2: The adding order of various rubber additives.

Optimization method considered: The sulfur should be added last to avoid early occurrence of vulcanization reaction during latex mixing.

Table S3. Mechanical properties of NR composites

Content of $Ti_3C_2T_x$ MXene （wt%）	Tensile Strength (MPa)	Elongation at Break (100%)	Shore Hardness (HA)	Modulus at 100% strain (MPa)	Modulus at 300% strain (MPa)
0	13.757±0.023	1291±18	35	0.7±0.1	1.5±0.1
0.5	14.816±0.138	1357±26	41	0.8±0.1	2.2±0.1
1.0	21.604±0.563	1485±35	47	0.9±0.1	2.0±0.1
3.0	20.155±0.428	1449±45	46	0.8±0.1	2.2±0.1

Table S4. The chemical protection properties of rubber and rubber composites.

Sample	Toxic chemical	BTT (min)	Ref.
Butyl rubber (IIR)	Sulfur mustard	830	[1]
GO/IIR	Sulfur mustard	928	[1]
Nitrile rubber	Acetone	13.2	[2]
Nitrile rubber	Dichloromethane	5.8	[2]
Nitrile rubber	Toluene	36.7	[2]
Bromobutyl rubber	Dichloromethane	16.5	[2]
Bromobutyl rubber	Toluene	23	[2]
NR	Acetone	34.7	[2]
This work	Toluene	52.8	/
This work	Dichloromethane	36.8	/
This work	Concentrated sulfuric acid	523	/

[1] L. Zheng, D. Wang, Z. Xu, L. Zhang, L. Liu, S. Wen, High barrier properties against sulfur mustard of graphene oxide/butyl rubber composites, Composites Science and Technology 170 (2019) 141-147. doi.org/Doi.

[2] D. De Kee, C.F.C. Man Fong, P. Pintauro, J. Hinestroza, G. Yuan, A. Burczyk, Effect of temperature and elongation on the liquid diffusion and permeation characteristics of natural rubber, nitrile rubber, and

bromobutyl rubber, Journal of Applied Polymer Science 78 (2000) 1250-1255.doi.org/Doi.