Electronic Supplementary Material (ESI) for Nanoscale.

Supporting Information

Pectin-Assisted One-Pot Synthesis of MoS_2 Nanocomposites for Resistive Switching Memory Application

Honglei Wang,[a] Jun Shi,[a] Jingyu Zhang,[a] Zhehao Tao,[a] Hongguang Wang,[b] Qingqing Yang,[a] Peter A. van Aken,[b] Runfeng Chen,[a]**

[a] State Key Laboratory of Organic Electronics and Information Displays & Institute of Advanced Materials (IAM), Nanjing University of Posts & Telecommunications, 9 Wenyuan Road, Nanjing 210023, China, E-mail: iamrfchen@njupt.edu.cn.

[b] Max Planck Institute for Solid State Research, Heisenbergstr. 1, 70569 Stuttgart, Germany, E-mail: hgwang@fkf.mpg.de.

1. Experimental

1.1 Chemicals.

Molybdenum sulfide (MoS_2) powder (<2 μm, 99%), pectin, N-methyl-2-pyrrolidone (NMP) (99%), isopropanol (IPA) (99%), ethanol (EtOH) (99%), and N,N-Dimethylformamide (DMF) (99%) were purchased from Sigma-Aldrich. Other chemicals are of analytical grade and used without further purification.

1.2 Characterization.

The morphology of the prepared MoS_2 nanosheets was characterized using a JOEL JEM-1230 transmission electron microscope (TEM) and atom force microscopy (AFM) equipped with a Dimension 3100 (Veeco, CA) in height mode. A spherical aberration-corrected microscope (JEOL JEM-ARM 200F) with a DCOR probe corrector (CEOS GmbH) at 200 kV was used for scanning transmission electron microscopy (STEM) and electron energy-loss spectroscopy (EELS) investigations. High-resolution TEM (HRTEM) characterization was performed on a Tecnai G2 F20 S-Twin electron microscope. We used a Hitachi S-4800 microscope to acquire scanning electron microscopy (SEM) images. The Raman studies of the films were carried out on a WITec CRM200 confocal Raman microscopy system with a laser excitation at 488 nm with an air-cooling charge coupled device (CCD) as the detector. X-ray photoelectron spectroscopy (XPS) data were collected using a PHI 3056 spectrometer with an Al anode source operated at 15 KV and an applied power of 350 W with samples mounted on indium foil. X-ray diffraction (XRD) patterns were obtained using a Rigaku miniflex II. UV-Vis absorption spectra were obtained from a Shimadzu UV-3600 spectrophotometer. Photographs were taken using a commercial Nikon camera.

2. Figure parts

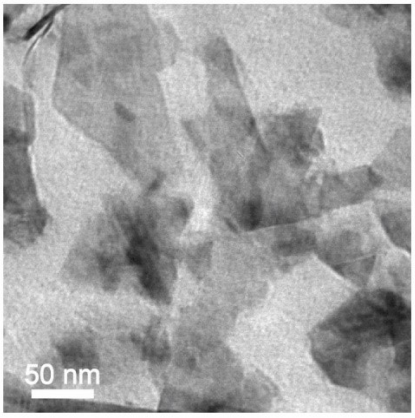

Fig. S1. TEM image of MoS_2 nanosheets.

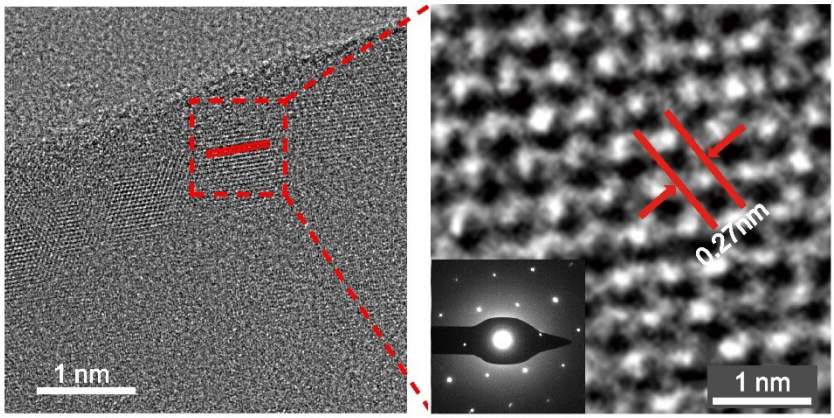

Fig. S2. TEM image and the corresponding selected area electron diffraction (SAED) pattern of MP10 (inset).

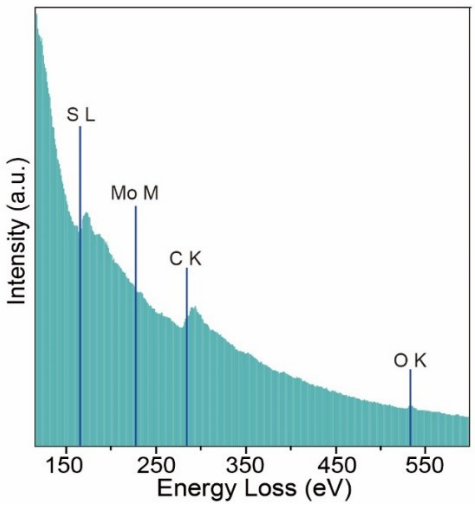

Fig. S3. The electron energy-loss spectroscopy (EELS) spectrum of MP10.

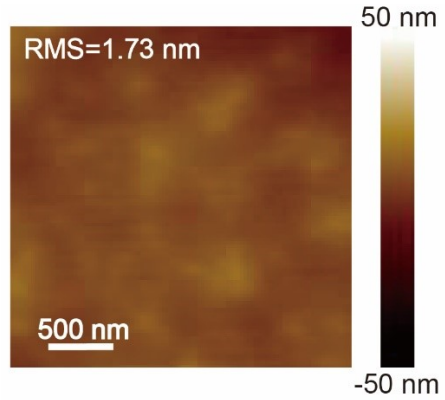

Fig. S4. AFM image of MP10 film.

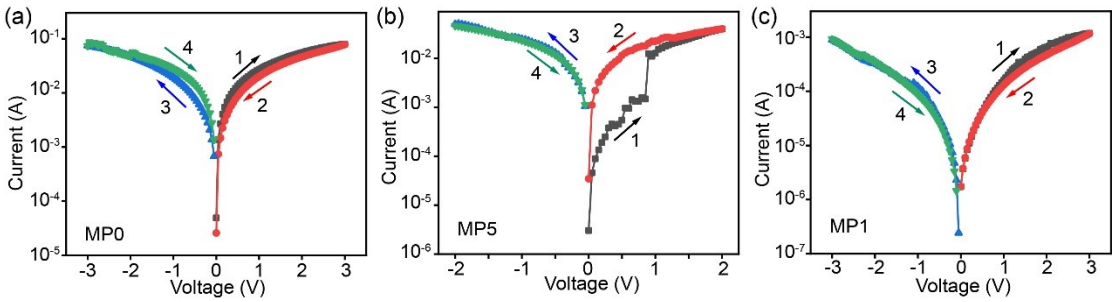

Fig. S5. I-V characteristics of the ITO/MPx/Al diode-memory devices, where x is 0 (a), 5 (b) and 1 (c), respectively.

Table S1. Summary of reported traditional liquid phase exfoliation methods in comparison to this work.

Materials [a]	Grinding solvent [b]	Sonicating solvent [b,c]	Sonication time	Layers of nanosheets	Reference
MoS_2	-	formamide	12 h	5 layers	1
MoS_2	-	DI water	8 h	9-10 layers	2
MoS_2	-	DMF	10 h	1-5 layers	3
Sericin/MoS_2	-	DI water	24 h	1-12 layers	4
Silk/MoS_2	-	NMP	10 h	4-8 layers	5
MoS_2	NMP	Ethanol/water	2 h	2-14 layers	6
MoS_2/CC	DI water	DI water	5 h	1-5 layers	7
MoS_2/pectin	-	DI water	3 h	1-7 layers	This work

[a] CC is Carboxylated chitosan.

[b] NMP is N-methyl-2-pyrrolidone.

[c] DMF is N,N-dimethyl formaldehyde.

Table S2. Summary of the nonvolatile memory device performances of the recently reported MoS_2-based nanocomposites.

Active layer material [a]	Memory effect	Retention time (s)	ON/OFF ratio	Threshold voltage (|V|)	Reference
MoS_2/PVP	Flash	__	10^2	3.5	8
MoS_2/PDA/*t*Bu_4PcTiO	Flash	10^4	10^3	2.85	9
MoS_2/PCBM	Flash	10^4	$3X10^2$	2.0	10
MoS_2/PTCA	WORM	10^4	10^5	5.5	11
MoS_2/rGO	Flash	10^4	~10	0.4	12
MoS_2/PVA	WORM	__	10^3	5.0	13
MoS_2/CC	WORM	10^4	10^3	5.7	7
MoS_2/Pectin	Flash	10^4	$5X10^2$	1.7	This work

[a] PVP is polyvinylpyrrolidone, PDA is polydopamine, PCBM is [6,6]-phenyl-C61-butyric acid methyl ester, PTCA is 3,4,9,10-perylenetetracarboxylic acid anhydride, PVA is polyvinyl alcohol, and CC is carboxylated chitosan.

REFERENCES

1 X. Gan, H. Zhao, D. Lei and P. Wang, *J. Catal.*, 2020, **391**, 424-434.

2 H. Ma, S. Ben, Z. Shen, X. Zhang, C. Wu, S. Liao and F. An, *Appl. Surf. Sci.*, 2020, **512**, 145588.

3 Y. Wang, K. Wang, C. Zhang, J. Zhu, J. Xu and T. Liu, *Small*, 2019, **15**, 1903816.

4 D. Kathiravan, B.-R. Huang, A. Saravanan, A. Prasannan and P.-D. Hong, *Sensor. Actuat. B-Chem.*, 2019, **279**, 138-147.

5 H. Sim, J. Lee, B. Park, S. J. Kim, S. Kang, W. Ryu and S. C. Jun, *Nano Res.*, 2016, **9**, 1709-1722.

6 Y. Yao, L. Tolentino, Z. Yang, X. Song, W. Zhang, Y. Chen and C.-P. Wong, *Adv. Funct. Mater.*, 2013, **23**, 3577-3583.

7 H. Wang, P. Cheng, J. Shi, D. Wang, H. Wang, J. Pezoldt, M. Stich, R. Chen, P. A. van Aken, W. Huang and P. Schaaf, *Green Chem.*, 2021, **23**, 3642-3648.

8 J. Liu, ZZ. Zeng, X. Cao, G. Lu, L. Wang, Q. Fan, W. Huang, and H. Zhang, *Small*, 2012, **8**, 3517-3522.

9 Q. Yan, F. Fan, C. Sun, M. E. El-Khouly, H. Liu, Y. Zheng, B. Zhang, G. Liu and Y. Chen, *J Mater. Chem. C*, 2021, **9**, 6930-6936.

10 W. Lv, H. Wang, L. Jia, X. Tang, C. Lin, L. Yuwen, L. Wang, W. Huang and R. Chen, *ACS Appl. Mater. Inter.* 2018, **10**, 6552-6559.

11 H. Wang, W. Lv, J. Shi, H. Wang, D. Wang, L. Jin, J. Chao, P. A. van Aken, R. Chen and W. Huang, *ACS Sustain. Chem. Eng.*, 2019, 8, 84-90.

12 L. Wu, J. Guo, W. Zhong, W. Zhang, X. Kang, W. Chen and Y. Du, *Appl. Surf. Sci.*, 2019, **463**, 947-952.

13 C. Yeon, S. J. Yun, J. Yang, D. H. Youn and J. W. Lim, *Small*, 2018, **14**, 1702747.