TECHSCALE

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High performance asymmetric supercapacitors enabled by tailored active sites in 2D transition metal dichalcogenides

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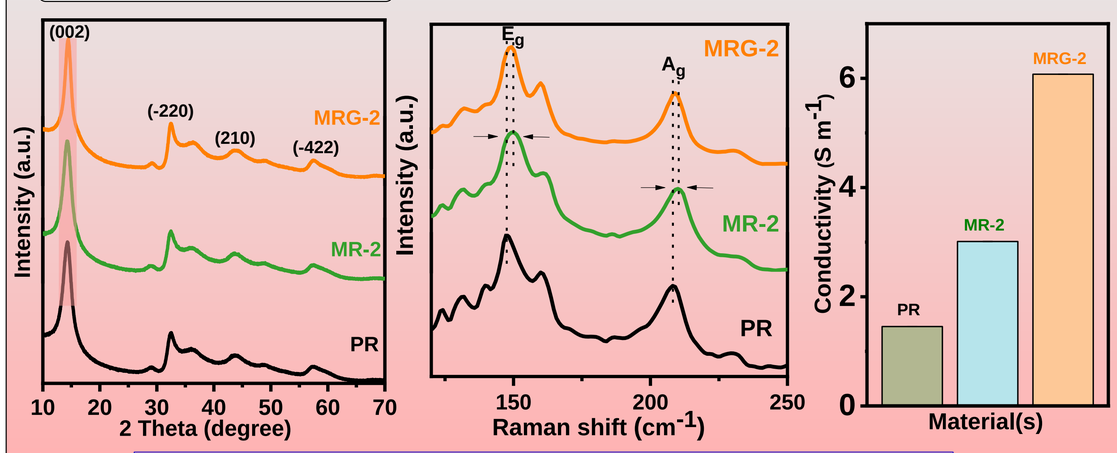
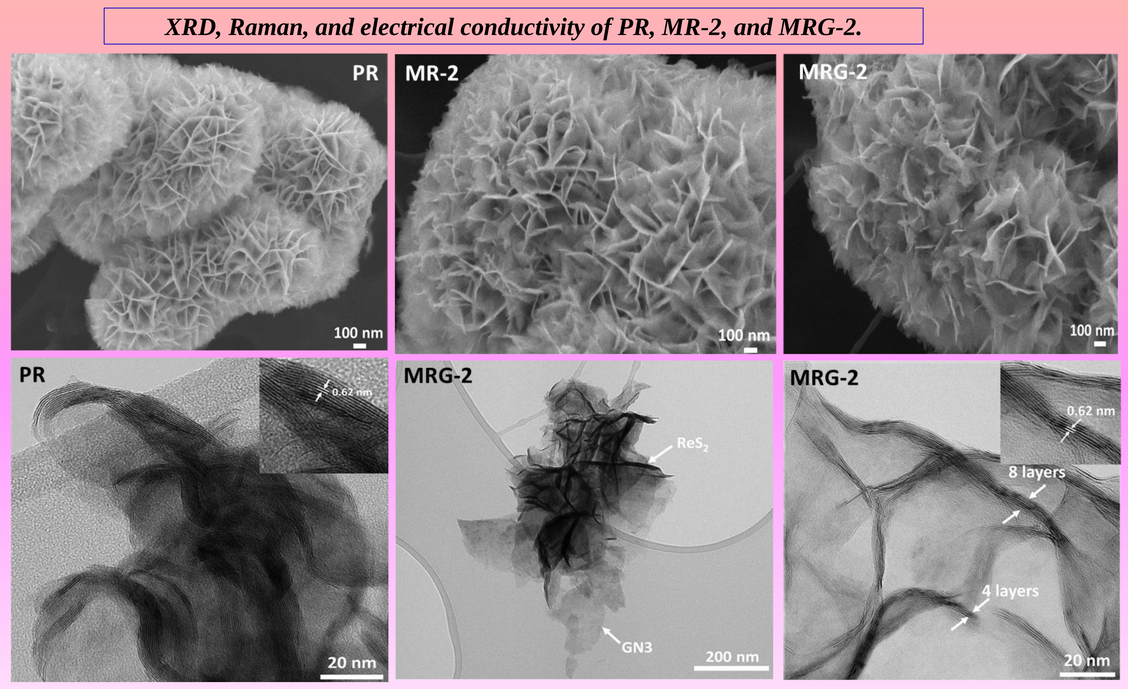
Objectives

- To modulate the active sites in 2D transition metal dichalcogenide by transition metal doping.
- To optimize the appropriate amount of transition metal doping in 2D TMD for enhancing the effective charge storage sites.
- To improve the electrical conductivity and structural stability of transition metal doped TMD by seamless integration with functionalized conductive graphene matrix.

Characterization

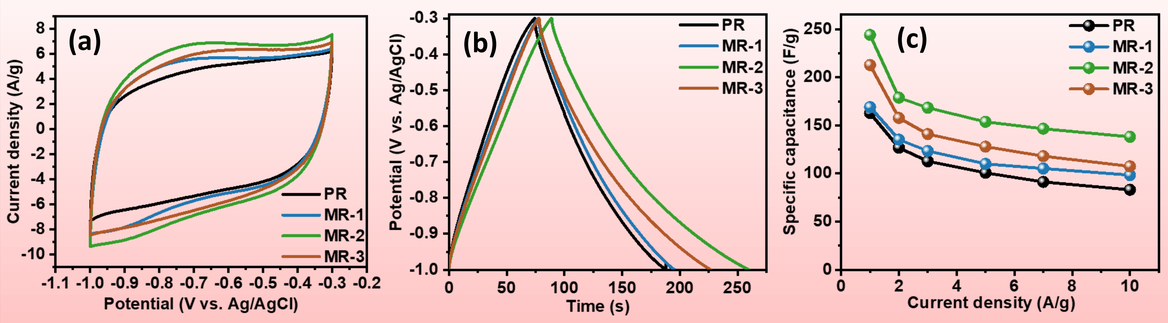


XRD, Raman, and electrical conductivity of PR, MR-2, and MRG-2.

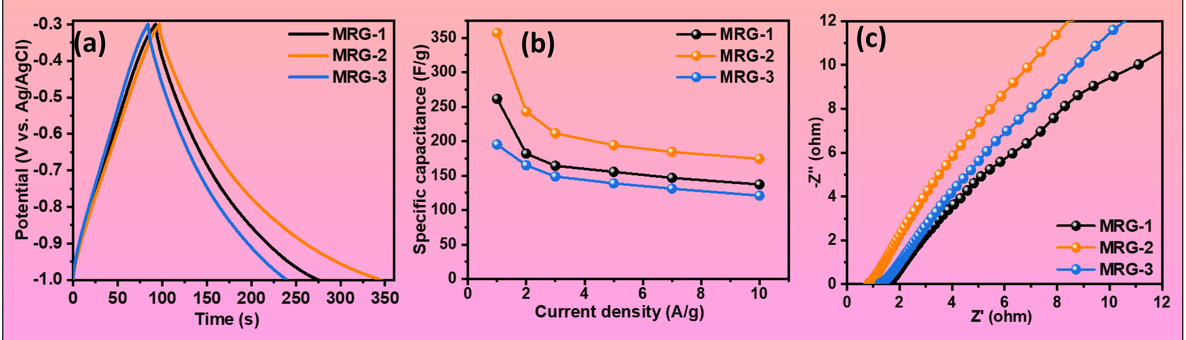


SEM images of PR, MR-2, and MRG-2. TEM images of PR and MRG-2

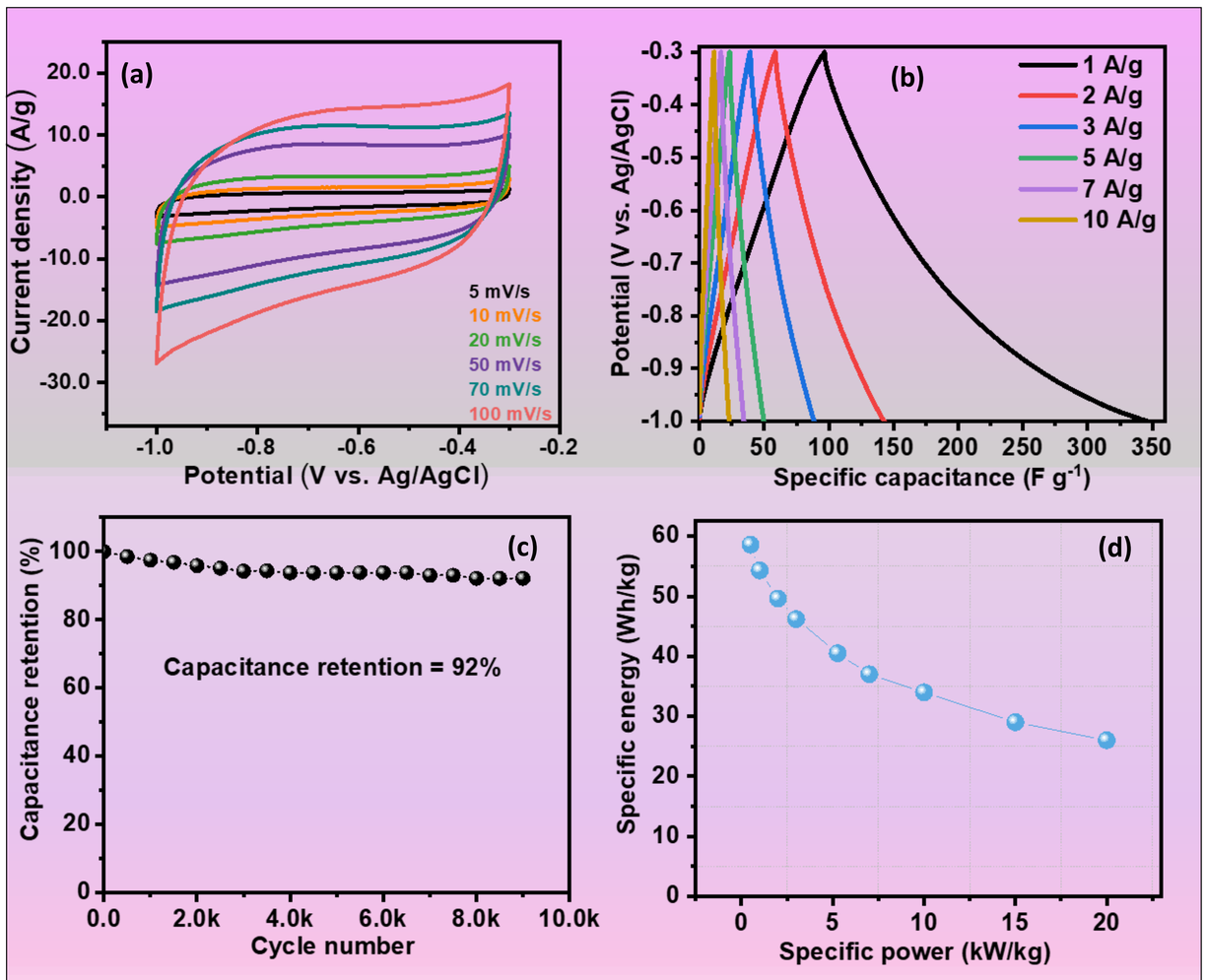
Electrochemical Measurements



Electrochemical measurements of PR and transition metal doped PR with different loadings. (a) CV curves of PR, MR-1, MR-2, and MR-3 at 50 mV/s. (b) GCD curves of PR, MR-1, MR-2, and MR-3 at 1 A/g. (c)Variation of specific capacitance as a function of current density.



Electrochemical measurements of transition metal doped PR seamlessly integrated with different concentrations of conductive functionalized graphene. (a) GCD curves of MRG-1, MRG-2, and MRG-3. (b) Variation of specific capacitance as a function of current density. (c) EIS spectra of MRG-1, MRG-2, and MRG-3.



Electrochemical measurements of MRG-2. (a) CV curves of MRG-2 at different scan rates. (b) GCD curves of MRG-2 at different current densities. (c) Cycling stability test of MRG-2 electrode. (d) Ragone plot of full cell asymmetric device.

Results

- The active sites of was engineered by transition metal doping in 2D TMD, enabling fast adsorption/desorption kinetics and improved charge storage capacity.
- The different transition metal atom loadings and concentration of functionalized conductive graphene substrate was found to be crucial for enhancing the electrochemical performance.
- The synergistic effect between transition metal atom doped TMD and conductive graphene resulted in extremely high specific capacitance compared with their counterparts.
- The asymmetric full cell device delivered the high energy density of 58.6 Wh/kg at a power density of 500 W/kg which is much higher than the state-of-the-art advance electrode materials. [1,2]

References

1. M. Pathak, P. Mane, B. Chakraborty, J. S. Cho, S. M. Jeong, C. S. Rout, *Small* 2024, *20*, 2310120.
2. J. Yang, C. Yu, X. Fan, S. Liang, S. Li, H. Huang, Z. Ling, C. Hao, J. Qiu, *Energy Environ. Sci.* 2016, *9*, 129.

Acknowledgements

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