Fabrication of Transparent Polyaniline-MoS_2 Nanocomposite Thin Films by Thermal Evaporation

Soumyasuravi Thakur*and Dr. Nirat Ray
Department of Materials Science and Engineering
Indian Institute of Technology Delhi, New Delhi, 110016, India
Soumyasuravi.Thakur@iitd.ac.in

Background and Motivation

	MoS_2	PANI
Properties	Unique optical, thermal, mechanical, and electrochemical properties	Good stability, interesting electroactivity, and unusual doping/dedoping chemistry

MoS_2-based PANI nanocomposites

Enhanced Properties: Photocatalytic Efficiency; Chemical stability; Electrochemical properties; Optical properties; Other properties

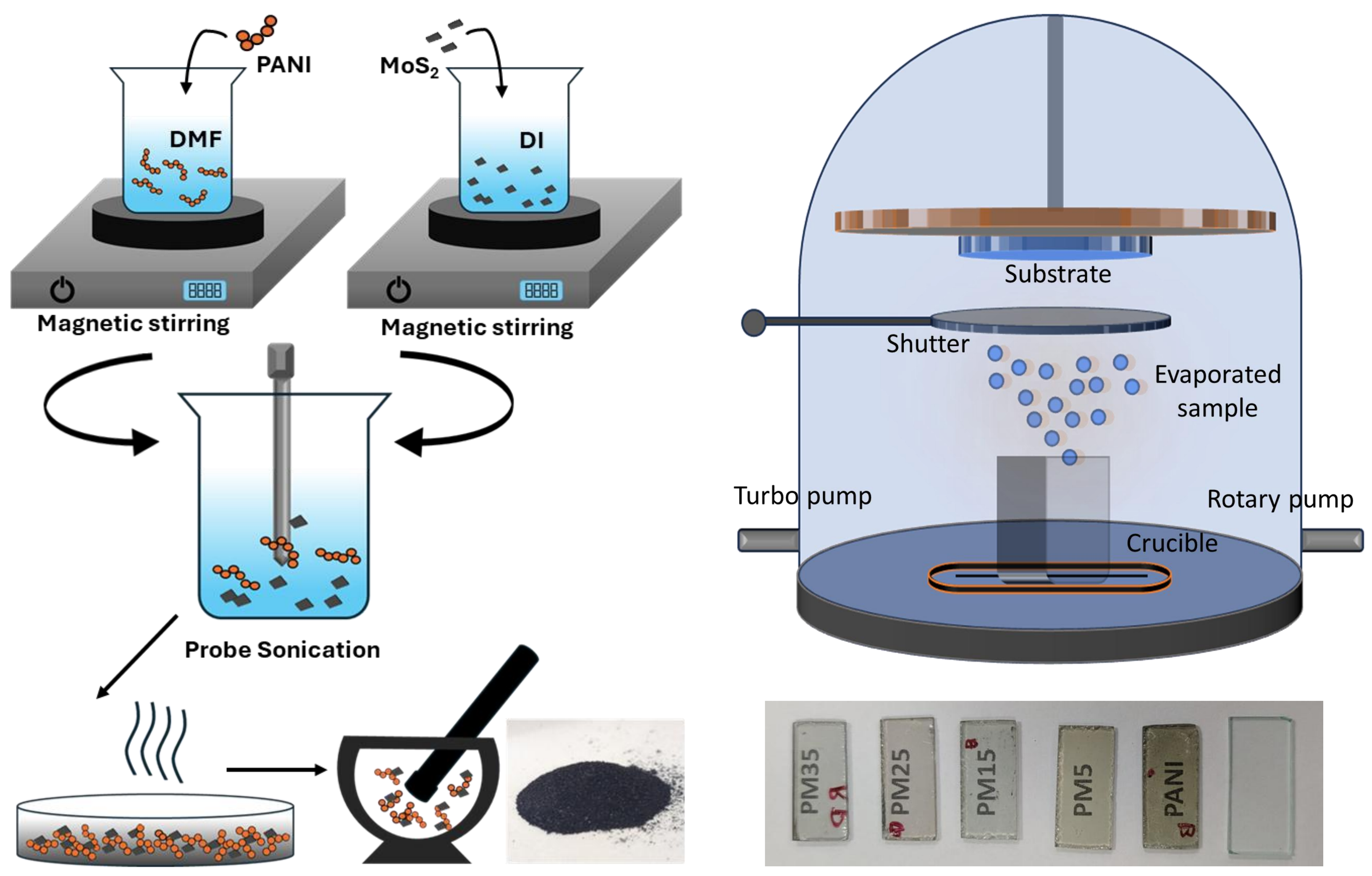
Applications: Hydrogen generation; Sensing platforms; Corrosion resistant coating; Electrode material; Photodetector; Flexible LEDs; Other applications

Major Challenges

- Development of scalable and practical methods for creating the nanocomposites in coating form.
- Complexities related to achieving uniform dispersion within a coating matrix while maintaining their desirable properties.

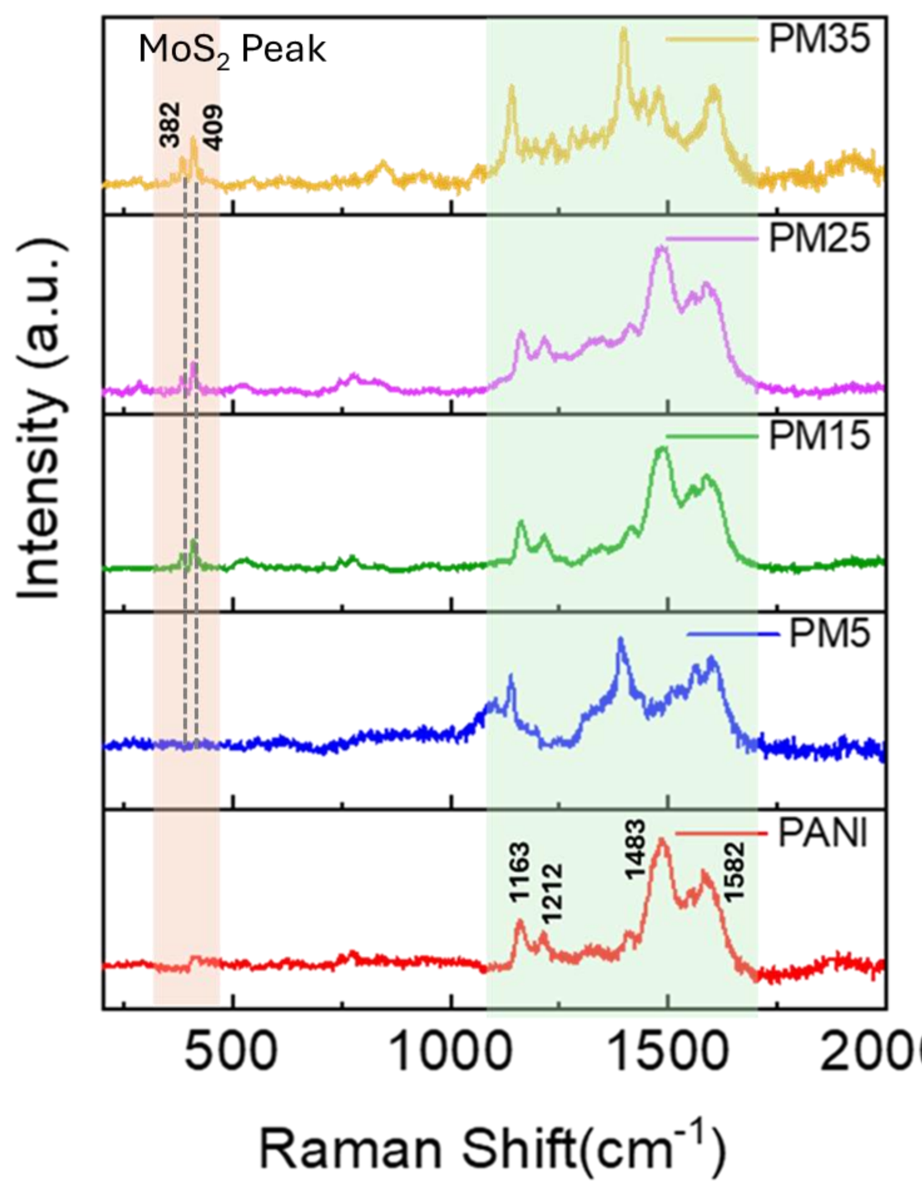
Thin film Fabrication

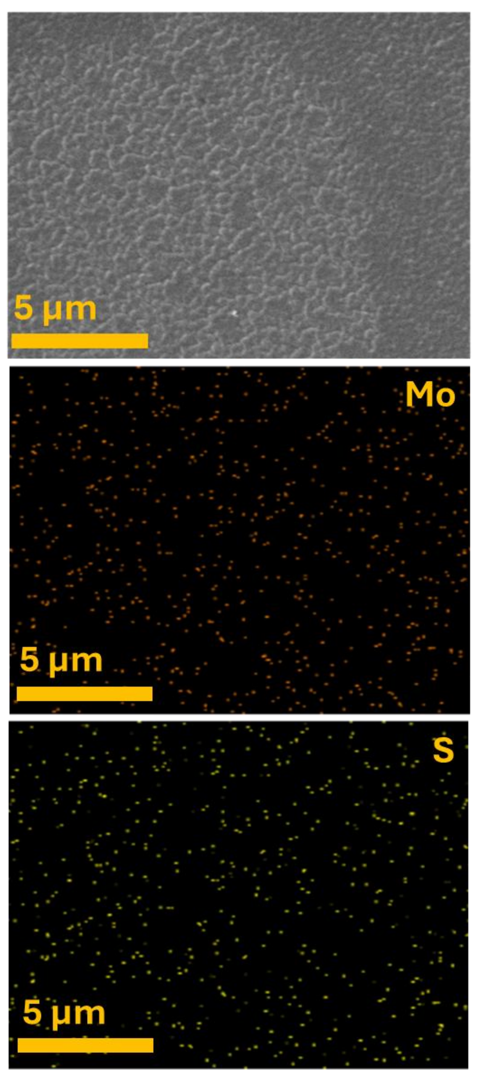
- Nanocomposites are synthesized by solution mixing route.

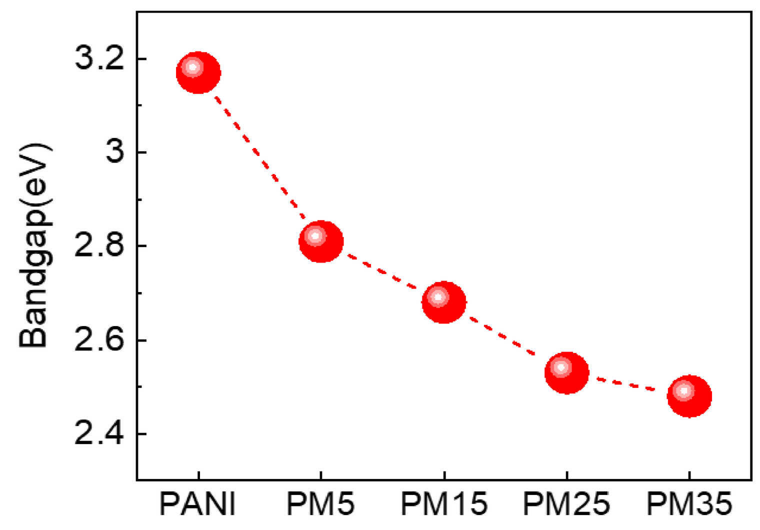


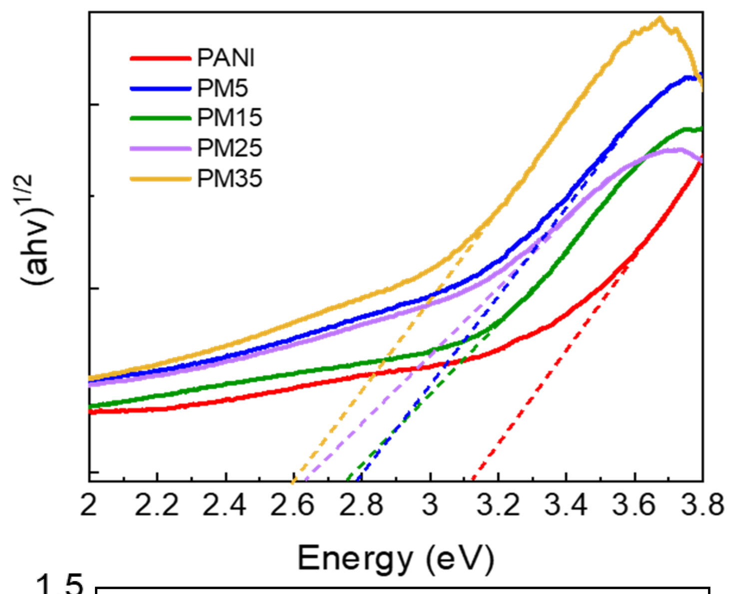
Optical images

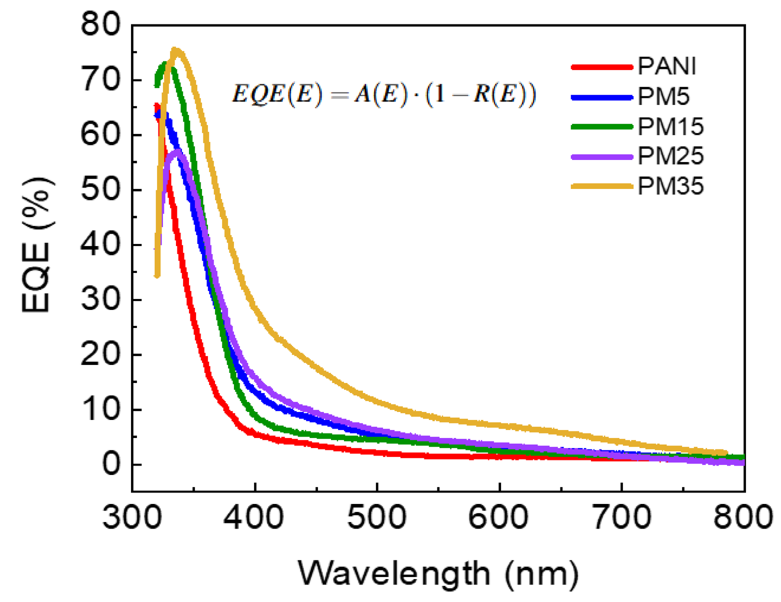
Results and Discussion

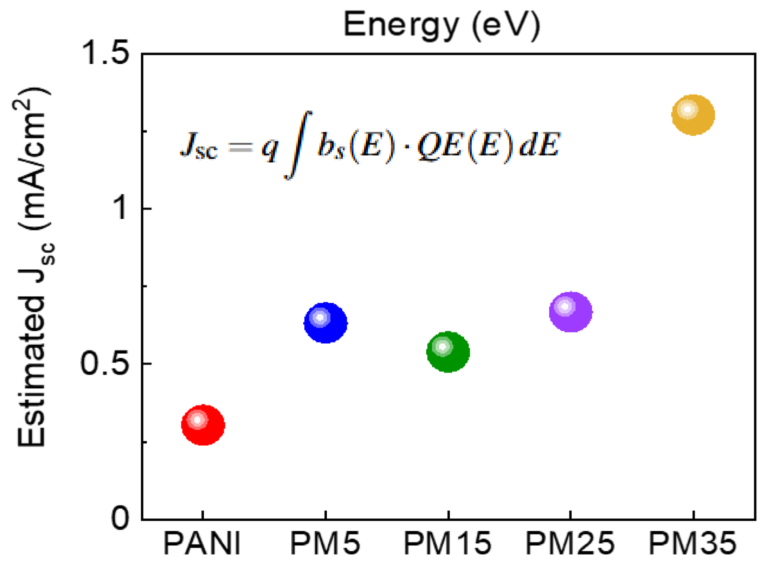




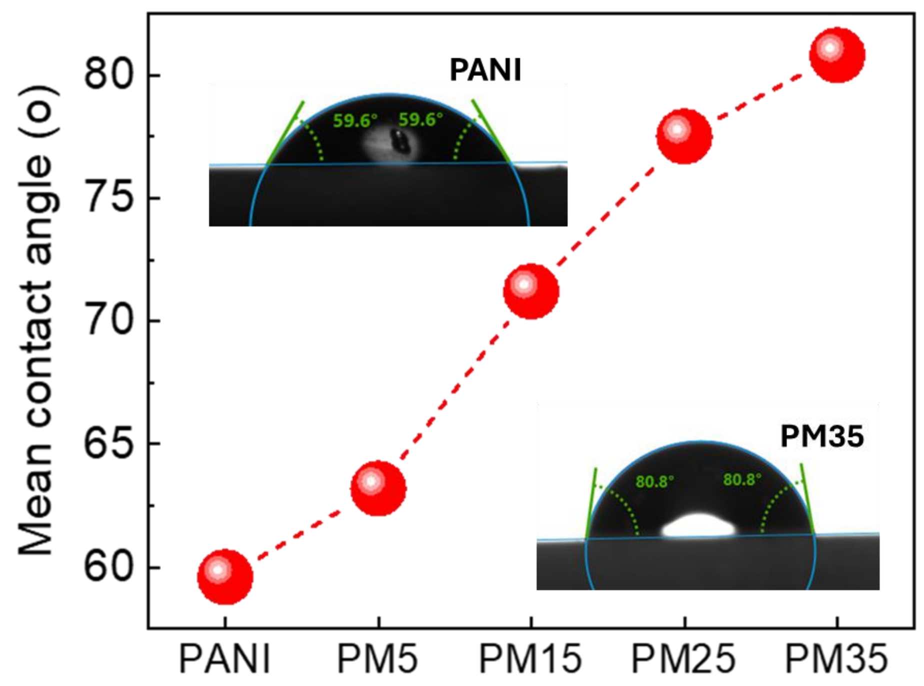


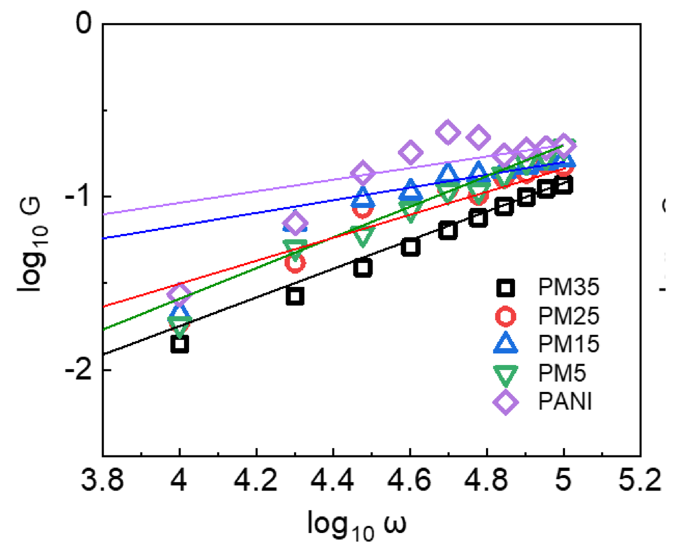




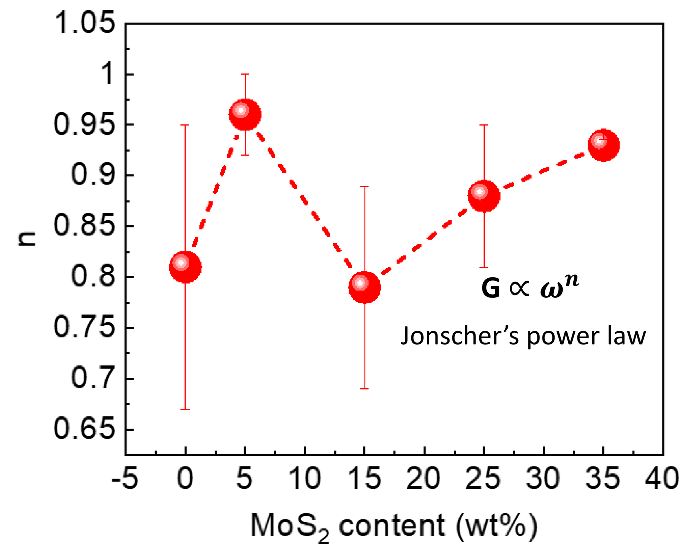


- It can be used as an absorber layer and lead to a potential 1.5 mA-cm^{-2} current generation.





- Become more hydrophobic with an increase in the MoS_2 loading concentration.
- Exponent n indicative of hopping conduction between localized states, suggesting a disordered system, where energy barriers between these localized sites limit transport.



Conclusions

- Innovative thermal evaporation method successfully produced thin films of MoS_2-polyaniline nanocomposites, opening up new avenues for scalable production, promise for applications in flexible electronics, transparent electrodes, and advanced coatings for a wide range of industries.
- Raman spectroscopy analysis unequivocally confirmed the incorporation of Mos_2 within the composite matrix, validating the nanocomposite's structural integrity.
- Observed the effect of MoS_2 loading in PANI, which reveals interesting bandgap modulation as the bandgap of the nanocomposite decreases with increasing loading concentration.
- The optical transparency of these films remained excellent, underscoring their potential for use in optoelectronic and transparent conductive coatings.

Acknowledgment

The author acknowledges the Central Research Facility and Nano Research Facility by the Indian Institute of Technology, Delhi for experimental resources. The author also acknowledges funding support from DST-SERB through Start-up research grant (SRG/2019/001143) and the Department of Higher Education, MHRD for the Senior Research Fellowship.

References

[1] Thakur, Soumyasuravi, et al. "Tuning the nanoscale tribological characteristics of thermally evaporated transparent polyaniline–graphene nanocomposite thin films." *Nanoscale* 17.18 (2025): 11366- 11375.
[2] Thakur, Soumyasuravi, Neeraj Rathee, and Nirat Ray. "Electronic properties of polyaniline–graphene nanocomposites synthesized via solution mixing method." *Journal of Physics: Condensed Matter* 37.7 (2024): 075702.
[3] Zhu, Haipeng, et al. "Nanocomposites of conducting polymers and 2D materials for flexible supercapacitors." *Polymers* 16.6 (2024): 756.
[4] Rehman, Asad Ur, et al. "Transition Metal Dichalcogenides, Conducting Polymers, and Their Nanocomposites as Supercapacitor Electrode Materials." *Polymer Science, Series A* 65.5 (2023): 447-471.