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Memcapacitive Devices Based on ZnO and Mg Thin Films: Toward Adaptive Energy Interfaces

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INTRODUCTION

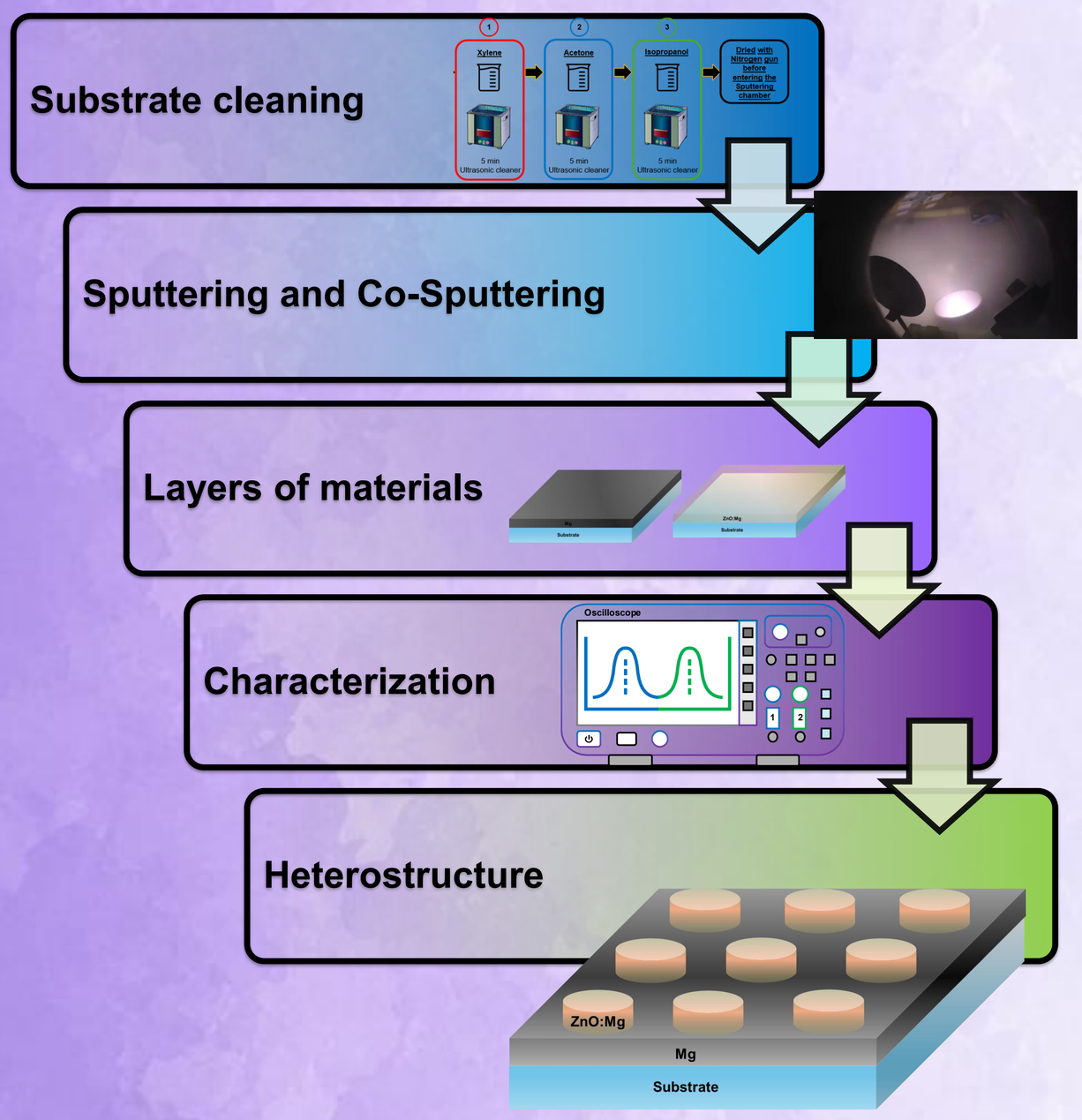
The fast evolution of smart and adaptive energy systems has intensified the demand for multifunctional materials capable of integrating energy storage, memory, and reconfigurable behavior within a single platform. In this context, memcapacitive systems have emerged as a promising class of components that combine capacitive functionality with memory effects.

In this work, we investigate memcapacitive behavior in thin-film devices based on zinc oxide (ZnO) and magnesium (Mg). Magnesium is introduced as an active material to modulate dielectric response, defect density, and interfacial polarization through different structural configurations, including layered and mixed thin-film arrangements.

This study establishes a materials-driven approach toward adaptive energy interfaces, where energy storage and memory functionalities coexist within flexible platforms. Such devices are highly relevant for low-power electronics, neuromorphic systems, wearable technologies, and intelligent energy-aware architectures

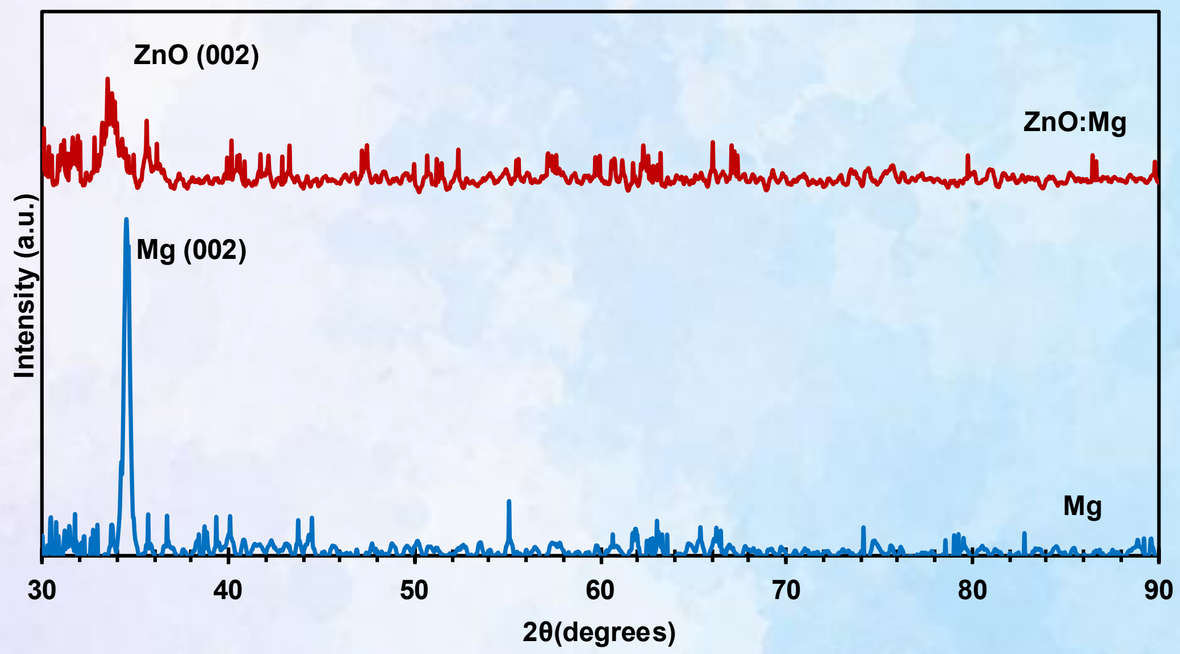
METHODOLOGY

All films were fabricated using sputtering techniques, allowing precise control over thickness and deposition parameters.

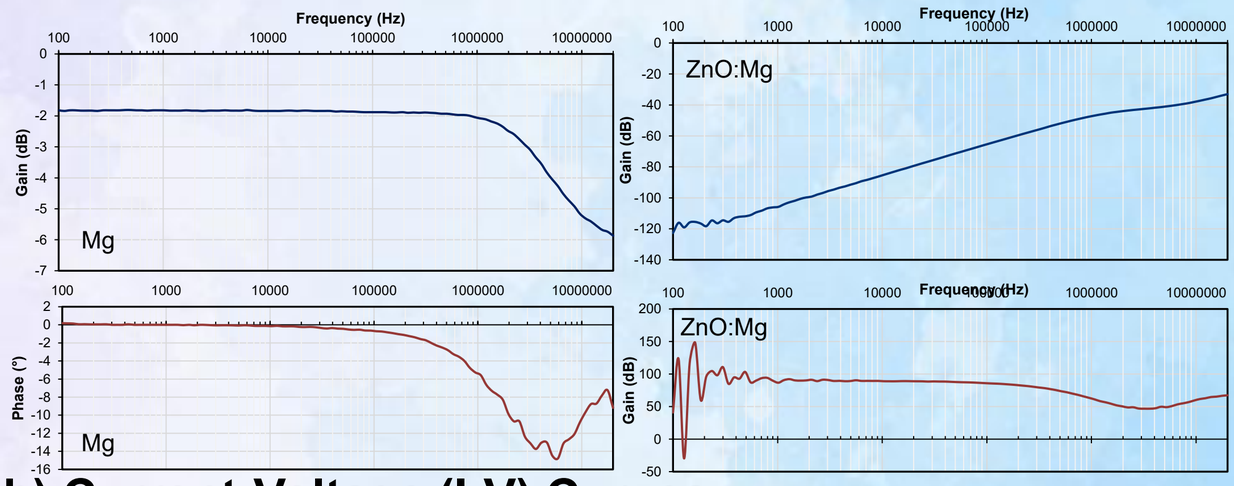


RESULTS & DISCUSSION

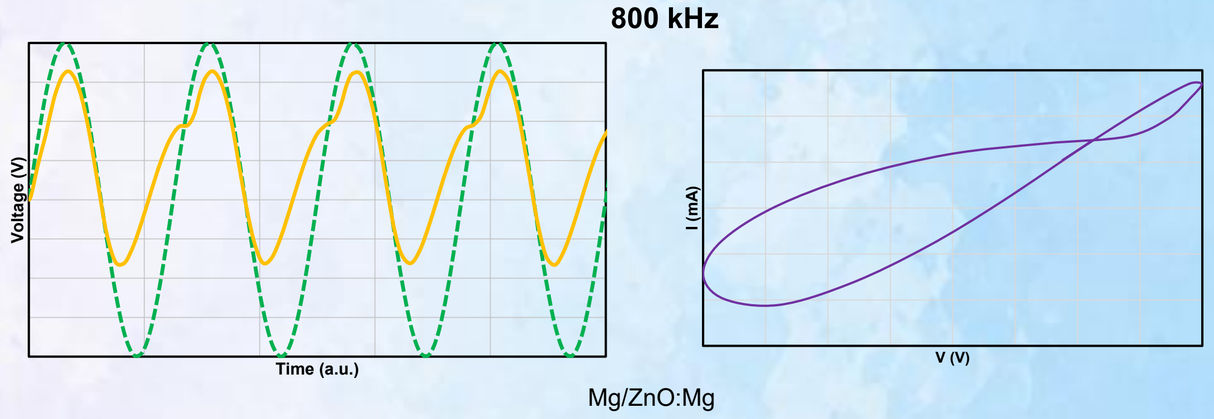
a) X-Ray Diffraction



b) Frequency Response Analysis



b) Current-Voltage (I-V) Curves



Mg/ZnO:Mg

CONCLUSION

ZnO-Mg thin films were successfully fabricated by sputtering, producing layered and mixed configurations with frequency-dependent electrical behavior. FRA and I–V results suggest interfacial polarization, charge-storage effects, and hysteretic response, indicating the potential of Mg-modified ZnO films as memcapacitive-like devices for adaptive energy interfaces.

FUTURE WORK / REFERENCES

Future work will focus on optimizing ZnO–Mg configurations, improving device stability, and exploring scalable integration strategies for next-generation smart energy systems.

Lv, Y., Guo, X., Li, X. et al. Coexistence of memristive and memcapacitive characteristics in Pt/MgO/ZnO metal-insulator-semiconductor heterostructure device. Appl. Phys. A ***131****, 251 (2025). https://doi.org/10.1007/s00339-025-08368-3*