

Figure 1. Comparison of ESD and efficiency performances of past planar-structured (Hf,Zr)O₂-based thin films works with this study.

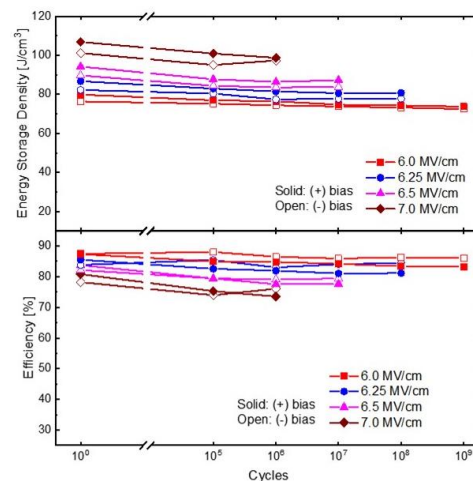


Figure 2. ESD and efficiency changes of Al₂O₃-inserted HZO films with cycling at field amplitudes of 6.0, 6.25, 6.5, and 7.0 MV cm⁻¹.

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References

- [1] Palneedi, H. et al. *Adv. Funct. Mater.* **28**, 1803665 (2018).
- [2] Silva, J. P. et al. *ACS Energy Lett.* **6**, 2208–2217 (2021).
- [3] Shin, J. et al. *J. Mater. Chem. C* **12**, 15423–15434 (2024).