Soft-based resistive-switching devices for artificial synapses

Pedro Ferreira[1*], Andreia V. Silva[1], João Ventura[1] and Catarina Dias[1]
[1]IFIMUP, Department of Physics and Astronomy, Faculty of Science, University of Porto, 4169-007 Porto, Portugal, *up202005899@up.pt

INTRODUCTION

The rapid expansion of big data and its critical role in modern decision-making highlight the limitations of traditional CMOS-based systems, which, as they continue to shrink and approach their physical limits, face challenges such as quantum effects, high power dissipation, and the von-Neumann bottleneck[1]. Neuromorphic computing emerges as a promising alternative, leveraging brain-inspired parallel processing. For instance, soft-material-based resistive switching devices, characterized by their moldability, easy solution processability, and low energy consumption[2], enable the integration of computation and memory in a single unit. This work focuses on developing polymeric salt-doped functional layers to emulate synaptic behaviour.

EXPERIMENTAL STUDY

Copper(II) sulphate was dissolved in distilled water, followed by the gradual addition of poly(vinyl alcohol) (PVA) under controlled heating to ensure full dissolution[3]. The resulting solution was used as the electrolyte layer in a two-terminal device comprising a platinum tip and a copper electrode. Device performance, including endurance, data retention, and thermal stability, was systematically evaluated.

RESULTS AND DISCUSSION

The device exhibited reliable I-V characteristics, with stable transitions between high- and low-resistance states (Figure 1a). The R_{off}/R_{on} ratio remained consistent over multiple cycles (10 shown), confirming reproducibility and endurance (Figure 1b). Furthermore, minimal performance variation across temperatures (Figure 1c) underscored its thermal stability. This simple fabrication method offers a robust, cost-effective solution for flexible and energy-efficient memory devices.

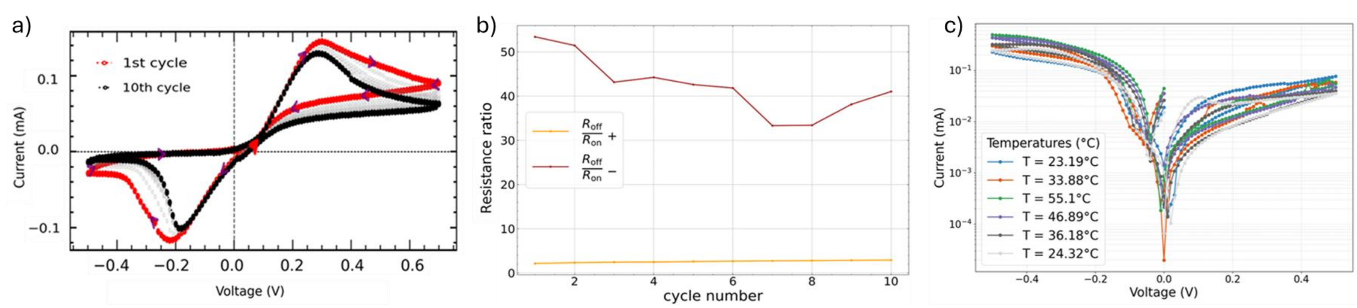

Fig. 1 (a) *I-V* characteristics, (b) R_{off}/R_{on} ratio for positive and negative polarity voltages (measure at 0.2 mV) and (c) temperature dependence of the device (X-Y ºC).

CONCLUSION

This study demonstrates the potential of salt-doped polymer-based resistive switching devices as a low-cost, scalable approach for neuromorphic computing. The devices exhibit good endurance, high resistance ratio, and thermal stability, paving the way for flexible and efficient memory applications under alternative device architectures.

REFERENCES

1. W. Chen et. al, *Adv. Electron. Mater.*, 2023, 9, 2200833
2. J. Xu et. al, Mater. Horiz., 2024,11, 4015-4036
3. R.S. Costa et. al, *J Mater Sci* **55**, 10121–10141 (2020)

ACKNOWLEDGMENTS

This work was financially supported by FCT and IFIMUP through projects LA/P/0095/2020, UIDP/04968/2025, UIDB/04968/2025, PTDC/NAN-MAT/4093/2021 and 2022.15710.UTA, and "La Caixa" Foundation within project CCO 204197.