Nickel Nanowire Networks for Scalable Neuromorphic Reservoir Computing

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INTRODUCTION

Neuromorphic devices, based on memristors to mimic artificial synapses, are a burgeoning field with potential applications in therapies for neurological disorders.[1] Since crossbar memristor devices face limitations such as scalability, variability, and efficiency, reservoir computing using stochastic nanowire networks offers a promising alternative. Memristive traits in these networks, combined with their nonlinear dynamics, low training cost, and scalable fabrication, make them attractive candidates for neuromorphic applications.[2] While silver nanowires are widely used for their conductivity and biocompatibility, they face scalability and reliability issues. Nickel nanowires (Ni NWs) emerge as a more stable, scalable, and cost-effective alternative.[3]

EXPERIMENTAL

In this study, we report the fabrication of neuromorphic devices based on Ni NWs coated with polyvinylpyrrolidone (PVP) through a simple chemical reduction process.[4] The neuromorphic devices were fabricated by coating the Ni NWs networks in flexible substrates (Kapton) using the spin-coating method.

RESULTS AND DISCUSSION

X-ray diffraction (XRD) and scanning electron microscopy (SEM) confirmed the presence of Ni and the nanowire morphology, while transmission electron microscopy (TEM), Figure 1a), confirmed the presence of PVP coating. The *i-V* measurements of NWs network exhibited a typical resistive switching (RS) curve with a high resistive set state (1 and 3) and a low resistance reset state (2 and 4), as shown in Figure 1b), which corresponds to a nonlinear volatile response. The PVP layer plays a crucial role in the RS mechanism, as nickel ions migrate through the PVP, forming a conductive bridge between nanowires. This behavior depends on the applied voltage and the conductive bridge can be dissolved and formed by adjusting it, thus mimicking synaptic functions that are essential for neuromorphic applications.

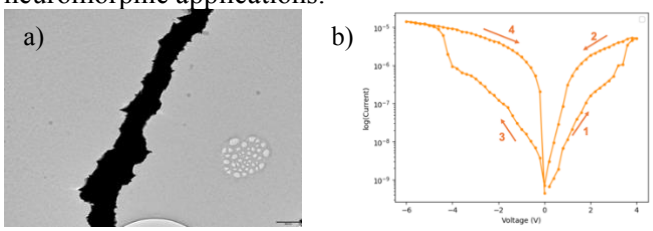

Fig. 1 a) TEM images of the nickel nanowire network. b) *i-V* measurement for a Ni NWs device exhibiting nonlinear volatile behavior.

CONCLUSION

Nickel NWs were successfully synthesized and used to fabricate a memristor device leveraging reservoir computing with self-assembled NW network. Structural and compositional analyses confirmed the quality of the Ni NWs and their suitability for neuromorphic applications. The PVP played a pivotal role in enabling RS behavior. This study highlights the potential of Ni NW-based devices as scalable and reliable alternatives for neuromorphic computing.

REFERENCES

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