Integration of vanadium dioxide nanowires in devices for high-frequency electronics and neuromorphics

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Vanadium dioxide (VO_2) is among the strongly correlated electron materials that exhibit an insulating-to-metal transition (MIT) and has garnered substantial research interest due to both its fundamental properties and its potential for integration into electronic, photonic, and neuromorphic devices. This interest stems from the significant changes in VO_2's electrical and optical properties during its MIT, which occurs at relatively low temperatures (around ~340K) [1]. Moreover, this transition can be induced by electrical or optical stimuli, making it highly versatile for practical applications. Scientific literature predominantly focuses on applications utilizing VO_2 thin films. Regardless of whether these films are epitaxial or polycrystalline, their MIT exhibits a co-existence of distinct phases and a percolative insulator-to-metal character. Recent advancements have demonstrated the application of Chemical Vapor Deposition and Vapor-Liquid-Solid techniques to fabricate VO_2 nanostructures and microstructures, including wires, plates, beams, and nanoparticles, in a straightforward manner [2]. Notably, these VO_2 structures are single-crystalline, a characteristic makes it possible to overcome the random, percolative domain structures typically observed in thin films. This monocrystalline structure is essential for the development of reliable and reproducible devices, addressing a significant limitation encountered with thin film performances. In this work, we present a comparative study of the properties of vanadium dioxide in the form of thin films and nanowires as illustrated in the fig. 1. Furthermore, we will discuss the potential integration of VO_2 nanowires into devices for high-frequency electronics and the rapidly evolving field of neuromorphic devices.

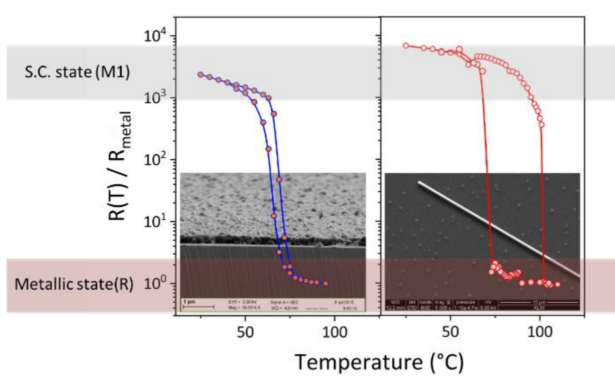

Fig. 1: Temperature evolution of VO_2 resistances in thin film and nanowire form

[1] J. P. Pouget, Comptes Rendus. Physique 22, no. 1, pp. 37-87 (2021)
[2] B. S. Guiton et al., J. Am. Chem. Soc. 127, 2, 498 (2005)