**Solution-processed molecular oxides as redox-active components in neuromorphic memories**

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Neuromorphic computing holds promise for lowering power consumption and increasing the computation speed of Artificial Intelligence (AI) applications, as it is emulating the parallel manner of memorising and processing information in the brain. Although machine learning algorithms inspired by the spiking neural networks in the brain have recently made gigantic leaps into the field of neuromorphic computing, scalability and power efficiency remain a challenge. There is, therefore, a clear need for redesigning the neuromorphic hardware systems using radically novel materials and architectures that can better emulate the chemical processes in the mammalian brain and lead to efficient computation with added functionalities.

Polyoxometalates (POMs), a class of redox active molecular metal oxides, have emerged as promising candidates for next generation neuromorphic devices. Their discrete molecular structure, tunable electronic properties, and compatibility with silicon-based platforms have made them attractive materials for advanced memory applications with tunable long- and short-term memory characteristics. POMs can accept multiple electrons without compromising their structural integrity, notably acting as “electron reservoirs” or “electron sponges”, while the highly tunable surface chemistry of these metal oxide clusters offers many routes for electronic device optimisation.

In this talk, I will present a two-terminal redox-based resistive switching memory using the Keggin phosphomolybdate POM H3PMo12O40. By combining this Mo-POM with nanogap coplanar metal electrodes, we create nanoelectronic devices that offer significant advantages, such as low power consumption and fast switching times. Emphasis will be placed on the diverse strategies used to integrate POMs with different metal substrates and functional layers, such as dielectric and conjugated polymers. I will also discuss the influence of counterions and encapsulating layers in resistive switching mechanisms.

This combination of redox active nanomaterials and nanogap architecture holds great potential for advancing electronic technologies, while being also fully compatible with large area manufacturing and flexible substrates. Overall, this work introduces POM-based systems as a viable alternative to the limitations of conventional CMOS memory, offering a blueprint for future developments in molecular electronics.