Electrical, chemical and microstructural characterisation of various amorphous carbon resistive switching devices

Raeber, T.[1], Barlow, A.[2], Zhao, Z.[3], McKenzie, D.[3], Partridge, J.[1], McCulloch, D.[1] and Murdoch, B.[1]

[1] School of Science, RMIT University, VIC 3001, Melbourne, Australia, [2] Centre for Materials and Surface Sciences (CMSS), Department of Chemistry and Physics, La Trobe University, VIC 3086, Melbourne, Australia, [3] School of Physics, The University of Sydney, NSW 2006, Sydney, Australia

Carbon-based memory technologies offer a potential replacement for current silicon-based CMOS electronics. Promising faster, cheaper and more durable computing, these technologies have been considered as building blocks for neural networks and other neuromorphic applications. In this work, we characterize carbon-based memory devices including all-carbon, bilayer and ion implanted amorphous carbon memristors made using physical vapor deposition techniques.

We have produced a range of different carbon films for active layers by varying deposition parameters including deposition temperature, substrate bias and the addition of reactive gases. A subset of these devices were also modified by He+ irradiation in a Helium Ion Microscope. The films were chemically and microstructurally characterised using techniques including electron energy loss spectroscopy, X-ray photoelectron spectroscopy and Raman spectroscopy. The devices exhibited systematic bipolar and unipolar resistive switching as well as several neuromorphic learning/memory functions. The versatility and tuneable nature of these carbon-based memory suggest potential in neuromorphic many-valued logic circuits.

The authors would like to acknowledge the Australian Research Council (ARC) for financial support under the ARC Discovery Projects scheme.