ABSTRACT:

How to Make a Memristor:
Proton Tunneling and Ion Diffusion at the Water-Graphene Interface

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Memristive devices, electrical elements whose resistance depends on the history of applied electrical signals, are leading candidates for future data storage and neuromorphic computing. Memristive devices typically rely on solid-state technology, while aqueous memristive devices are crucial for biology-related applications such as next-generation brain-machine interfaces. Here, we report a simple graphene-based aqueous memristive device [1] with long-term and tunable memory. Its operation relies on reversible voltage-induced interfacial acid-base equilibria, selective proton permeation through the graphene, and slow ion diffusion to the interface [2,3]. These results pave the way for developing experimentally straightforward and conceptually simple aqueous electrolyte-based neuromorphic iontronics using two-dimensional (2D) materials.

[1] Y. Wang, T. Seki, P. Gkoupidenis, Y. Chen, Y. Nagata, M. Bonn, Proc. Nat. Ac. Sci.., in revision.

[2] Y. Wang, T. Seki, X. Liu, X. Yu, C.-C. Yu, K.F. Domke, J. Hunger, M.T.M. Koper, Y. Chen, Y. Nagata, M. Bonn, Angew. Chem. Int. Ed., DOI: 10.1002/anie.20221660 (2023).
[3] Y. Wang, T. Seki, X. Yu, C.-C. Yu, K.-Y. Chiang, J. Hunger, Y. Chen, Y. Nagata, M. Bonn, Nature, DOI: 10.1038/s41586-022-05669-y