Title:
Advancing Iontronics: Unleashing the Potential of Microfluidic Memristors in Computing

Abstract:
The energy consumption of machine learning is doubling every 2 months. This will outpace the global energy production within the next decade. The energy bottleneck largely stems from the limitations of the von Neumann architecture inherent to our computers, where the processor is physically separated from the memory, requiring the need to copy data to do a computation. The emergence of iontronics, a field at the intersection of ionic conductors and electronics, has opened new pathways for the development of unconventional computing architectures no longer limited by the von Neumann architecture.

Microfluidic memristors, a subset of iontronic devices, have gained attention for their tunable electrical properties and potential for low-power computing, by enabling computation and memory operations to occur at the same place. Our ionic memristors are comprised of a conical channel with fixed surface charge density, filled with an ionic liquid. We have constructed simple memristive circuits, capable of performing nonlinear classification tasks such as the XOR problem, as well as implementing the fundamental building block of computers, the NAND-gate, enabling us to tackle more complex tasks using memristive circuits. Furthermore, we have first results of simple regression tasks performed in simulated hardware. We anticipate significant advancements in areas such as machine learning, neuromorphic computing and beyond, facilitated by these innovative developments.