

Spintronic and Ionitronic Computing Technologies

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Recent advances in manipulating spin-polarized electron currents in atomically engineered magnetic heterostructures make possible entirely new classes of sensor, memory and logic devices - a research field generally referred to as spintronics. A magnetic recording read head, initially formed from a spin-valve, and more recently by a magnetic tunnel junction, has enabled a 1,000-fold increase in the storage capacity of hard disk drives since 1997. The enormous storage capacity of arrays of hard disk drives in the “cloud” has made possible the digital storage and access to all of humankind’s knowledge since the beginning of mankind, thereby ushering in the age of “Big Data” and data analytics. The creation of unforeseen data-driven businesses and the transformation of entire industries is impacting society in manifold ways. Increasing the performance and reducing the energy consumption of storage and computing technologies will very likely spur yet more innovative applications of such technologies. Spintronic and ionitronic devices that rely on atomically engineered materials have novel properties that may allow for higher performance, lower energy, and more compact computing devices. The Racetrack Memory is a novel three-dimensional technology that stores information as a series of magnetic domain walls in nanowires, manipulated by spin-polarized current. Racetrack Memory, a spintronic technology - combines the best attributes of magnetic disk drives – their very low cost per stored bit - with those of solid-state memories – their high performance and reliability. Ionitronics allows for the reversible, non-volatile transformation between insulating and metallic states via the flow of tiny currents of ions. Such devices may allow for “plastic” devices that mimic synaptic switches in the brain, thereby allowing for the possibility of very low power computing devices.