Redox-Based Switching – the Next Step of Moore´s Law?

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Abstract

After following Moore´s law for more than four decades, the exponential performance increase of silicon based CMOS technology will run into inherent technological and physical limits by 2020. In particular, the Flash memory, widely spread used in MP3 players, cameras, and smart phones, suffers from limits in voltage scaling and endurance. A potential leap beyond these limits may emerge from redox-based switching effects encountered in oxides and higher chalcogenides. A range of systems exist in which ionic transport and redox reactions on the nanoscale provide the essential mechanisms for bistable resistive switching. One class relies on mobile cations which are easily created by electrochemical oxidation of the corresponding electrode metal, transported in the insulating layer, and reduced at the inert counterelectrode. Another important class operates through the migration of anions, typically oxygen ions, towards the anode, and the reduction of the cation sublattice in the layer locally providing metallically or semiconducting phases. In all systems, the defect structure turned out to be crucial for the switching process.

Despite exciting results obtained in recent years, huge challenges have to be met before these physical effects can be turned into industrial technology. This presentation will outline the fundamental principles, the prospects and challenges, as well as the open questions.