Ph.D. in Information Technology: Theses Defenses

February 8th, 2019

Room Alpha – 10.00 am

Alessandro BRICALLI – XXXI Cycle

"Fabrication and characterization of resistive switching memory devices for high-density storage and in-memory computing"

Advisor: Prof. **Daniele Ielmini**

Abstract:

Modern computing systems are facing fundamental challenges in processing large amounts of information efficiently, mainly due to the latency gap existing between the CPU and storage devices. Many approaches to solve this problem have been proposed, from the development of novel high-performance memories, to the implementation of non-Von Neumann computing paradigms such as neuromorphic computing and in-memory computing. Emerging non-volatile memories and devices based on 2D materials are promising candidates for this kind of application. This dissertation focuses on the fabrication and electrical characterization of novel resistive switching devices, as well as the demonstration of non-Von Neumann computing paradigms. First, the fabrication and electrical characterization of silicon oxide-based ReRAM devices is discussed. The results about the fabrication and characterization of a cross-point array of memory elements are later addressed. Afterwards, a novel planar device which exploits resistive switching mediated by MoS_2 is presented. Finally, brain-inspired logic gates using ReRAMs and an innovative system for solving linear algebra problems with cross-point arrays of memristors are discussed.

Valerio MILO – XXXI Cycle

"Modeling and simulation of spiking neural networks with resistive switching synapses"

Advisor: Prof. **Daniele Ielmini**

Abstract:

Nowadays, functions such as the recognition of speech, image, and faces, are becoming essential features in various applications, from smartphones to driver-less cars. However, the development of these cognitive systems offers critical challenges, in terms of accuracy, speed, energy efficiency, and cost. In this context, achieving brain-inspired circuits and algorithms seems a very promising pathway, given the unrivaled energy efficiency and computing performance of the human brain. Toward this goal, nanoscale devices capable of

mimicking the biology of learning in silico such as resistive random access memory (RRAM) are highly valuable.
In my Ph.D. dissertation, the implementation of spike-timing dependent plasticity (STDP) and spike-rate dependent plasticity (SRDP) biological learning rules by RRAM-based synaptic structures is first demonstrated. Afterward, moving from device to network level, simulation and experimental results supporting the capability of two-layer feedforward spiking neural networks (SNNs) with RRAM-based synapses to achieve unsupervised learning of visual patterns are presented. Finally, the ability of Hopfield-type recurrent SNNs with RRAM-based synapses to capture other fundamental brain-inspired primitives such as associative memory, pattern completion and error correction is also investigated by simulations.

Gianluca NICOSIA – XXXI Cycle

"Performance and reliability issues of NAND Flash cells at the transition from planar to 3-D array architectures"

Advisor: Prof. **Christian Monzio Compagnoni**

Abstract:

The Ph.D. research provides an in-depth understanding of the main reliability issues that affect the last planar NAND Flash technology node, discussing single-electron phenomena, and 3-D NAND Flash arrays, analyzing the impact of the polycrystalline nature of the channel on their reliability.

PhD Committee:

Prof. **Daniele Ielmini,** DEIB
Prof**. Elisabetta Chicca**, Bielefeld University
Prof**. Luca Selmi**, Universita' di Modena e Reggio Emilia