polifab
POLITECNICO DI MILANO

22 April, 2016

Workshop on

Spintronics

Room S.0.5, Building 3 – Gino Cassinis
Politecnico di Milano
P.za L. da Vinci 32, 20133 Milano

With the aim of supporting and aggregating education and research activities, Polifab organizes a series of workshops on emerging themes related to micro and nanofabrication technologies. The first one is devoted to Spintronics. This emerging research field is based on the manipulation of the electron spin in nanostructured samples and is aimed to develop new devices, such as memories, sensors and computing elements.

Starting from the basic principles and an historical review of Spintronics, three tutorials of 45 minutes will provide a broad range view of the topic and will lead the audience towards the newest developments and trends of this research field.

Programme

14.30 R. Bertacco, Politecnico di Milano, *Deputy Director of Polifab*
Spintronics: basic principles and emerging trends

15.15 J. Fontcuberta, Institut de Ciència de Materials de Barcelona, *IEEE lecturer*
Spin-orbit mediated magnetoresistance in oxide antiferromagnets and metal/ferrimagnet bilayers

16.00 F. Ciccacci, Politecnico di Milano, *Head of Department of Physics*
Spin properties in Semiconductors

Next workshops are scheduled as follows:

12 May 2016:	Neuromorphic computing systems
10 June 2016:	Micro-Electro-Mechanical Systems (MEMS)

Registration

The participation is free but subject to registration on this link:
http://tinyurl.com/Polifab-workshop

Contact: infopolifab@polimi.it, Phone: +39 0223998980
How to reach the room S.0.5: http://tinyurl.com/roomS05

Spintronics: basic principles and emerging trends

R. Bertacco

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Spintronics is an emerging research field in nanoelectronics, aiming at exploiting the additional degree of freedom of the electron spin in novel device architectures. In this talk the basic principles of conventional spintronics will be first reviewed, starting from the discovery of Giant Magnetoresistance in 1988 and then following the historical evolution of this research field, till to the industrial development of MRAMS based on Spin Transfer Torque magnetic tunneling junctions. Beyond classical spintronic devices, for sensing and memory applications, nowadays the research is moving towards the exploitation of spin in computing architectures. In the second part of the talk a brief overview on emerging trends will be given, with particular reference to the cases of coherent spin manipulation in Rashba systems and spin-wave propagation in magnonic conduits.

Spin-orbit mediated magnetoresistance in oxide antiferromagnets and metal/ferrimagnet bilayers

J. Fontcuberta

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Antiferromagnets have been used for decades as passive layers in magnetic memories. However, this rather peaceful and tedious status has been perturbed by the discovery of the new properties that emerge from the combination of antiferromagnetic coupling and spin-orbit interactions. Indeed, recently the magnetic ordering of antiferromagnetic oxides has been found to be the source of unexpected properties, such as ferroelectricity, or spin-dependent tunable electronic density of states or even exploit their properties in a new generation of robust magnetic memories. In all cases spin-orbit coupling is the toggle key that allows manipulating the magnetic ordering by electrical charges and *viceversa*. We will describe recent advances on using spin-orbit coupling in antiferromagnetic insulators (Sr_2IrO_4) to obtain a significant anisotropic magnetoresistance. Spin-orbit interaction can also be the source of magnetoresistance in metals. Most interestingly, magnetoresistance is also observed in non-magnetic metals when placed adjacent to ferromagnetic insulators in bilayer structures. We will show here that in Pt/$CoFe_2O_4$, a magnetoresistance develops in the Pt layer that is well described by the Spin Hall effect, the so-called the spin Magnetoresitance (SMR), which is strongly dependent on the crystallographic orientation of the $CoFe_2O_4$ layer, thus suggesting that the SMR could be also used as a sensitive probe to surface magnetization.

Spin properties in Semiconductors

F. Ciccacci

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The presentation will deal with the spin physics in semiconductors, including a historical review (starting from the first pioneering studies of the sixties and seventies) and more recent developments aimed to the realization of new spintronic devices. A few experimental methods to investigate spin properties in semiconductors will be discussed, as well as the important role played by modern deposition/fabrication techniques which make possible the realization of nanostructured samples (ultrathin films, quantum well, multilayers, superlattices). Topics such as electron spin injection and spin relaxation times in bulk and nanostructured semiconductors will be addressed. Particular emphasis will be given to optical based methods and to nanostructures based on group IV semiconductors, a research field in which the Polimi group is particularly active.