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From the discovery to the control of THz spin currents: Towards ultrafast spintronics

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The debate over the origin of the ultrafast demagnetization has been intensively active for the past 16 years. Several microscopic mechanisms have been proposed but none has managed so far to provide direct and incontrovertible evidences of their validity. In this context we have proposed an approach based on spin dependent electron diffusion as the driver of the ultrafast demagnetization. Recent experimental findings have revolutionized the field by confirming the existence of spin superdiffusion. We have shown that 1) spin diffusing away from a layer undergoing ultrafast demagnetization can be used to create an ultrafast increase of magnetization in a neighbouring magnetic layer, 2) optical excitation is not a prerequisite for the ultrafast demagnetization and that spin unpolarized electrons superdiffusing into a ferromagnetic layer can trigger ultrafast demagnetisation, and 3) superdiffusive spin currents can be tailored by appropriate choice of materials and used to produce broadband THz emission via the inverse spin Hall effect. The impact of these new discoveries goes beyond the solution of the mystery of ultrafast demagnetization. It shows how spin information can be, not only manipulated, as shown 16 years ago, but most importantly transported at unprecedented speeds. This new discovery lays the basis for femtosecond spintronics.

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Functionalized carbon nanotubes as immunomodulator systems and ultrasound contrast agents

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Carbon nanotubes have been studied for a wide variety of applications included in medicine as drug delivery systems, targetable materials and diagnostic tools. Carbon nanotubes, toxic in their pristine forms, have been functionalized with many different techniques to make them biocompatible. It was showed the potential use of well functionalized carbon nanotubes (f-CNTs) as ultrasound contrast agents. It was studied the interaction of f-CNTs and primary immune cells and was proposed f-CNTs as immunomodulators showing their potential as activators of the immune systems. Moreover, it was recently evaluated, the possibility of taking advantage of immunostimulatory properties of f-CNTs against microgravity immune function dysregulation. Obtained results proved that the capacity of f-CNTs to stimulate immune cells have very interesting broad future applications not only in immunotherapy or as vaccine adjuvants, as we recently suggested, but also to contrast spaceflight immune cells functionality suppression. Results from different investigations, functionality assays and their potential as theranostic materials will be presented and discussed.

Biography

Lucia Gemma Delogu now is Assistant Professor and head of the laboratory of Bionanotechnology and Biochemistry at the University of Sassari, Italy. She got her BSc focusing on genetics and the PhD on Biochemistry and molecular biology. She was post doctoral fellow at the University of Southern California, USA (2007-2009). She was visiting researcher at the National Institute of Health of Bethesda (USA) in 2013. She got the title as "Best 200 Italian Talents" from the Italian Ministry of Youth in 2011, she got the "Del Prete: Medicine, biology and nanotechnology Award in 2012" and "the Bedside to bench & Back Lecture Series Achievement Award" in 2013 at the NIH Bethesda, USA. She is part of the editorial board of *Journal of Translational Medicine*. Her laboratory focuses on functionalized carbon nanotubes, graphene, superparamagnetic iron oxide nanoparticles and nanocapsules and their interaction with the immune system at the gene and protein level. She also studies the different nanomaterials as potential ultrasound contrast agents.

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