Invited Talk

———

Lattice-mismatched heterostructures based on group IV semiconductors as an advanced spin-optronics platform

Fabio Pezzoli

LNESS and University of Milano-Bicocca, via R. Cozzi 55, 20125 Milano, Italy

fabio.pezzoli@unimib.it

Group IV semiconductors are emerging as solid-state hosts of spin-based information. Besides being low-cost and readily-available substances, they possess highly desired features, such as long spin lifetimes and diffusion lengths [1]. Group IV semiconductors can additionally leverage wafer-scale epitaxy, which introduces confinement, alloying and strain as effective degrees of freedom for the simultaneous manipulation of electronic, photonic and spin-dependent properties [2].

Here we will discuss how band-structure engineering of the hetero-interface between Ge and Si offers the exciting possibility of studying the impact of spin-orbit coupling on conduction band electrons. We experimentally demonstrate the manipulation of the Landé g-tensor over a record-high tuning range for group IV materials [3]. Finally, by combining time- and polarization-resolved photoluminescence with electron spin resonance we unveil spin relaxation times approaching few μs in Ge and rivaling with the one of the lighter Si counterpart.

These findings are contributing to stimulate the emergence of new research frontiers at the intersection between magnetism, electronics and optics. Finally, we will discuss prospects for heteroepitaxial architectures based on novel SiGeSn alloys and how they can possibly enrich conventional devices with photonic and spintronic benefits in terms of energy efficiency and information processing speed [4,5].

[1] R. Jansen, Nat. Mater. 11, 400-408 (2012).

[2] F. Pezzoli et al, Phys. Rev. Lett. 108, 156603 (2012).

[3] A. Giorgioni et al, Nat. Commun. 7, 13886 (2016).

[4] S. De Cesari et al, Electronics 6, 19 (2017).

[5] S. De Cesari et al, Phys. Rev. B 99, 035202 (2019).