Efficient transfer of large-area perpendicularly magnetized magneto-resistive structures on flexible substrates using a versatile Au-mediated transfer-and-bonding strategy

M. Hassan[1,3], S. Laureti[1], C. Rinaldi[2], S. Petrò[2], S. Varotto[2], G. Barucca[3], N. Safonova[4], M. Albrecht[4], G. Varvaro[1*]

[1]Istituto di Struttura della Materia, CNR, NM2-Lab, Monterotondo Scalo (Roma), 00015, Italy
[2]Department of Physics and IFN-CNR, Politecnico di Milano, via G. Colombo 81, 20133 Milano, Italy
[3]Università Politecnica delle Marche, Dipartimento SIMAU, Via Brecce Bianche, Ancona 60131, Italy
[4]Institute of Physics, University of Augsburg, Universitätsstraße 1 Nord, D-86159 Augsburg, Germany

Flexible spintronic devices have received a great deal of attention over the past few years thanks to the wide number of advantages (lightness, flexibility, shapeability, wearability and low cost) with respect to the conventional rigid counterpart [1]. While the progress and development of longitudinal magnetized devices on non-planar substrates has been remarkable over the last years, no studies are reported, to the best of our knowledge, about magneto-resistive systems with perpendicular magnetic anisotropy on flexible substrates, despite such systems are of great relevance with regards to non-volatile memories and sensing applications.

In this work, a versatile and effective *transfer-and-bond* approach exploiting the low adhesion to the substrate of a gold layer is proposed to obtain magneto-resistive heterostructures with perpendicular magnetic anisotropy on large-area flexible substrates. To demonstrate the feasibility of the proposed strategy, perpendicular magnetized [Co/Pd]-based spin valves, consisting of a fully compensated $[Co/Pd]_N/Ru/[Co/Pd]_N$ synthetic antiferromagnet (SAF) reference electrode and a $[Co/Pd]_N$ free layer were used as model systems. The heterostructure is first deposited on a conventional thermally oxidized Si (100) substrate covered with a thin *weakly adhering* Au layer and then transferred on an adhesive and flexible tape by mechanical peel-off.. Centimeter-scaled spin valve stacks were successfully transferred on a commercial adhesive polyester tape without degrading their magnetic and magneto-resistive properties, thus confirming that the proposed Au-mediated transfer-and-bond approach can be pursuit to obtain complex spintronic heterostructures on large-area flexible substrates, including systems whose fabrication process requires high temperature treatments.

[1] M Melzer et al. J. Phys. D: Appl. Phys. **53** (2020) 083002

[2] G. Varvaro et al., Nanoscale **11** (2019) 21891