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【14】Molecular Spintronics: towards the active control of nano-scale hybrid units

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The miniaturization trend in the semiconductor industry has led to the understanding that interfacial properties are crucial for device behaviour. Spintronics has not been alien to this trend, and phenomena such as preferential spin tunnelling, the spin-to- charge conversion due to the Rashba–Edelstein effect and the spin–momentum locking at the surface of topological insulators have arisen mainly from emergent interfacial properties, rather than the bulk of the constituent materials.
In this talk, I will describe inorganic/molecular interfaces by looking closely at both sides of the interface: the <i>molecular side</i> and the <i>inorganic side</i>, as schematically depicted in the figure. For the molecular side, focus is put on the description of how the orbitals of the free molecule develop as a function of the distance from the metal surface, i.e., when the hybridization with the metallic substrate is slowly turned on. This results in a description in terms of the energy level alignment at the interface, of the spin and charge transport across the interface, and of the magnetic coupling between the magnetic moments on the metal and on the organic components. On the other hand, when looking at the interface from the inorganic side, focus is put on the modification of the local spin and electronic properties of the surface atoms (such as the exchange constant and the local magnetic moment) induced by the hybridization of the molecular component.
I will review recent developments in the field of molecular spintronics within this framework, and underline how molecular materials have arisen as an ideal platform for creating interfacial spin effects [1]. As an example for the molecular side description, I will discuss the spin-filtering properties of the Co-Alq3 interface [2]. Within the inorganic side description, I will show that the extreme multi-functionality of organic molecules can be used to control the spin properties of surfaces with a spin-texture induced by strong spin-orbit coupling. I will present our results on the following two-dimensional electronic systems: the surface states of the topological insulator Bi2Se3 [3], and the Rashba-split surface states of a Pb-Ag surface alloy [4].
To conclude, I will discuss the key role that molecular interfaces may play in the development of a new generation of spin-based technologies, thanks to their unique capability of being actively tuned to reach as-yet unexplored functionalities [1].

References

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