Accessing the Interface via Photoemission-Based Techniques

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The interface is a fundamental component of modern devices and significantly affects their performance. When considering organic–inorganic interfaces, molecule–substrate interactions play a central role in spin and charge injection, thereby strongly influencing the physical, magnetic, and chemical properties of the system. In our group, we investigate the interfacial electronic properties of extended molecular systems—ranging from self-assembled molecular layers to two-dimensional metal–organic frameworks—on a variety of substrates, including ferromagnetic surfaces, coinage metals, and single-layer two-dimensional materials (*e.g.* transition metal dichalcogenides and graphene). These systems are studied using a multi-technique approach comprising low-energy electron diffraction, X-ray photoelectron spectroscopy, and photoemission orbital tomography. Additional magnetic and electronic characterization is performed at synchrotron facilities using X-ray absorption spectroscopy (XAS) and X-ray magnetic circular dichroism (XMCD), both of which provide extremely high elemental sensitivity.

In the first part of the talk, I will introduce our experimental toolbox and provide a brief overview of the capabilities of our photoemission electron microscope (PEEM) for investigating molecular adsorbates on surfaces. I will then present our current research projects, focusing on recent results concerning the interaction of pentacene with a oxygen-passivated Fe(100) surface and upon insertion of a magnesium oxide buffer layer. Different interaction regimes, ranging from chemisorption to integer charge transfer, will also be discussed.

Subsequently, I will introduce the two-dimensional metal–organic frameworks (MOFs) and covalent organic frameworks (COFs) under investigation, which are based on metal–tetrapyridyl porphyrin (M-TPyP), dicyanoanthracene (DCA), and carbonyl-bridged triphenylamine precursors, presenting preliminary results on their electronic structure and magnetic properties.

At last, I will show our current work on on-surface synthesis of transition metal dichalcogenides that can be used a template for growing highly-oriented molecular films and building heterointerfaces. I will focus in particular on the Pentacene/WS_2 and ReS_2/Au(110) system. While the first is a prototypical type II heterojunction, in the latter, the strain introduced by the anisotropic substrate modifies the electronic properties of the TMD making it conductive.