

High-energy resolution core level photoelectron spectroscopy

Alessandro Baraldi

Department of Physics, University of Trieste

Since the pioneering work of Kai Siegbahn, core-level spectroscopy has played a central role in unraveling the geometric and electronic structure of solid surfaces. Owing to their highly localized character, core electrons provide remarkably sensitive probes of the chemical state and local atomic environment. Core-level binding energies can respond to changes in atomic coordination, bond distances, charge redistribution, and interactions between different chemical species, allowing chemically and structurally non-equivalent atomic configurations to be distinguished.

The combination of the very high energy resolution achievable today—better than 50 meV under optimized experimental conditions—with increasingly fast data acquisition, reaching the millisecond timescale, has considerably expanded the scope of core-level spectroscopy. In particular, synchrotron radiation has transformed the technique into a powerful tool for investigating the physical and chemical properties of low-dimensional materials and for following complex processes occurring at surfaces and in nanostructured systems.

In this lecture, I will introduce the basic concepts underlying core-level photoelectron spectroscopy and illustrate its capabilities through selected recent experimental examples. Particular emphasis will be placed on how synchrotron-based experiments can provide atomic-scale insight into the interaction of atoms and molecules with solid surfaces and into the evolution of materials under different environmental conditions.

Epitaxial graphene on transition-metal surfaces will provide one representative case study, illustrating how core-level spectroscopy can reveal growth mechanisms, interactions with adsorbates, thermal expansion, and structural and thermal stability. Finally, recent investigations of supported, size-selected nanoclusters will be discussed to demonstrate how core-level spectroscopy can distinguish different atomic configurations and electronic states, providing access to the unusual properties that emerge when matter approaches the sub-nanometre scale.