Hard X-ray photoelectron spectroscopy for material science applications

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Investigating buried interfaces, device electronics or batteries by chemically sensitive instrumentation is highly desired in materials science applications. X-ray photoelectron spectroscopy (XPS) is a powerful method to investigate the chemical nature of surfaces. However, investigations of buried interfaces occurring in, e.g., device electronics are difficult as the energies of the created photoelectrons are not high enough and scattering inside the material's bulk limit the detected signal intensity.

During the past decade, increased attention has been shown to hard X-rays in the photoelectron spectroscopy field [1]. This is primarily due to the increased information depth enabled by the higher photon energies.

Using Scienta Omicron's HAXPES Lab, featuring a monochromatic Ga Kα X-ray source in combination with a hemispherical electron analyzer that includes a +/- 30 degree acceptance angle [2], we were able to investigate buried interfaces, in-operando devices and real world samples (Fig.1 A). [3] In this presentation we will give an overview of applications with a focus on bias-applied measurements from device electronics. Si-based materials are widely used in the semiconductor industry and are subject to chemical changes upon voltage application. Investigating a layered structure of 4 nm thick ZrO_2 on 20 nm TiN on p-doped Si, the binding energy shift could be characterized upon applied voltage in-operando without sample destruction. These changes can be assigned to trapped carriers in the defect level at the Ti-N/p-Si interface. (Fig. 1 B, C).

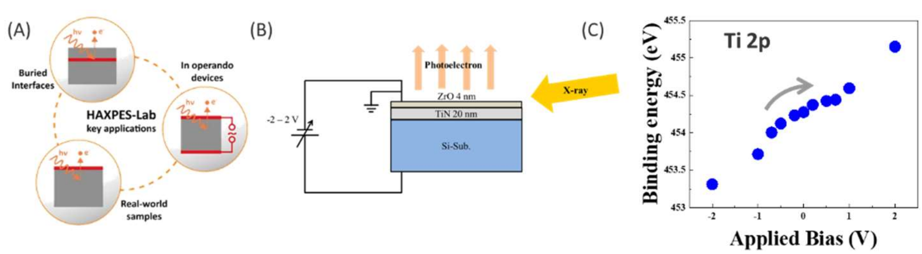

Figure 1: Application area of HAXPES-Lab (A) and example of destruction free, in-operando investigation of layered materials (B, C)

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