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Lab-scale Hard X-ray Photoelectron Spectroscopy for the analysis of buried interfaces in device technologies

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Photoelectron spectroscopy plays a key role in the characterization of surfaces and interfaces which is of primary importance in the field of device technology. However, instruments traditionally available in the lab are usually equipped with Al K α radiation (1486.6 eV), which limits the probing depth and therefore prevents from analyzing buried interfaces deeper than a few nanometers without resorting to destructive methods such as sputtering, causing strong chemical modifications.

However, in many modern technologies, the interfaces of interest are most of the time deeply buried underneath metal electrodes or oxides layers, requiring deeper analysis. This can be achieved by using higher energy photons. Hard x-ray photoelectron spectroscopy (HAXPES) have long been available at synchrotron facilities but its limited access lessen its interest as process development requires routine measurements and high reactivity. The recent advent of commercial lab-scale instruments opens new possibilities for non-destructive buried interface analysis [1-2].

In this presentation, we present the possibilities offered by a novel Cr K α (5414.8 eV) lab-scale HAXPES instrument (*Quantes*, Physical Electronics Inc.). The first part is devoted to the chemical analysis of buried interfaces in TiN/HfO₂ stacks intended for oxide-resistive random access memories (OxRAMs). The influence of a metallic Ti layer deposited at the interface is especially examined. Results reveal that the addition of a Ti layer promotes the reduction of hafnium oxide thus creating oxygen vacancies, which in turn greatly determine the device properties. The second part focuses on quantitative aspects on this new instrument and in particular describes an approach to determine relative sensitivity factors. The accuracy of the empirically derived sensitivity factors is confirmed by the quantitative analysis of binary and ternary compounds.

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References

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