Addressing Problems in Microelectronics with Spectromicroscopy

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The ongoing development in information technology leads to increasingly smaller devices. At the same time the device complexity grows. Relevant feature sizes in microelectronics reach down to 35 nm presently, magnetic tunnel junctions in spintronics approach the 50 nm limit, and the functionality in resistive materials depends on extended defects on the nanometer scale. In addition, the device structures often comprise layer stacks and/or complicated multinary compounds. In many cases the device properties depend crucially on the chemical composition and the quality of the interfaces. The combination of small length scales and chemical complexity leads to particular challenges in the experimental characterization of the electronic and chemical states.

This situation calls for new spectroscopic approaches with sufficient lateral and/or depth resolution. Photoelectron spectroscopy is a well-proven and versatile technique to study valence and core electronic levels. It is complemented by X-ray absorption spectroscopy. The conventional way of using these spectroscopies provides only a moderate lateral resolution. Employed as contrast mechanisms in an immersion lens electron microscope, however, they enable one to address chemical, electronic and magnetic states on a nanoscale. The parallel imaging capability of this spectromicroscopy allows even real time studies with a time-resolution down to the picosecond regime and unfolds its full power when employing synchrotron radiation as excitation source.