ULTIMATE NANOPROBING IN UHV: FOUR INDEPENDENT SCANNING TUNNELING MICROSCOPES NAVIGATED BY HIGH RESOLUTION UHV SEM

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Nanotechnology is rapidly growing scientific field and on it´s way to maturity in terms of integrating single nano-devices into large integrated circuits. Beyond that, also semiconductor industry is already approaching device dimensions on the nano-scale as can be seen from the International Technology Roadmap for Semiconductors. All these device technologies require high resolution topographical and chemical analysis with well established experimental techniques or electrical characterisation using standard probing systems. Nevertheless, typical instrumentation lacks from one fundamental problem: Bridging dimensions of a fully integrated circuit (mm range) down to the nanometer range (or even atomic scale) of single devices by using an adequate integrated navigation system. Moreover, the development of typically very sensitive nano-devices require ultra clean conditions, a goal which is best achieved under true UHV conditions.

To meet these new requirements, we have established a new approach integrating state-of–the art SPM technology with high resolution electron microscopy and spectroscopy. On the one hand bridging dimension and rapidly navigate while combining different surface analysis methods at the very same sample area to gain complementary information. On the other hand pushing each single technology to the limits required by nowadays nanotechnology.

The UHV Nanoprobe (Fig.1) facilitates four independent Scanning Tunneling Microscopes, each one equipped with 3D coarse positioning and full STM capability. A UHV Gemini SEM column with ultimate resolution down to 3nm is used for navigation of the four probes and rapid localisation of sample features or devices. STM imaging can be engaged to exactly position the local probe to the desired device. Using STM probe approach technology, a controlled electrical contact is ensured and finally all four SPM probes act as a four-point measurement device on the nano-scale.

Beyond that, the UHV Gemini SEM column itself has unsurpassed performance: Low beam energies down to 100eV avoid sample damage, but even more important imaging on insulators is also possible (Fig.2). On the other hand, beam currents up to 10nA make this electron source an ideal base for high resolution Scanning Auger Microscopy (SAM). Using a dedicated NanoSAM energy analyser, an ultimate SAM resolution below 10nm allows for chemical analysis.

References:

Figures:

Fig.1: The UHV Nanoprobe

Fig.2: SEM image of ZnO Nanocrystals at 200eV