Time-Resolved Photocurrent Mapping

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Nanotechnology Solutions Partner

Park Systems : Committed to Support Your Research

For over 25 years, Park Systems has developed reputation as the AFM technology leader among major universities, renowned research institutes and industry leaders seeking nanometrology solutions. The company's dedication to support AFM user's research and applications resulted in Park Systems developing the most number of modes with its XE-AFM among the existing AFM manufacturers in the market.

Enabling Innovation in Photosensitive Materials Research

Building upon the strength of its state-of-the-art conductive-AFM options, Park Systems has developed a ground-breaking capability of **Time-Resolved Photocurrent Mapping (Tr-PCM)**. The **mapping mode** measures the temporal response of photo-sensitive materials to time-resolved illumination without any interference from unwanted light source including AFM's feedback laser.

- Time-domain spectroscopy of photocurrent excitation by monitoring the response to the time-resolved light illumination

- Performing automated spectroscopic analysis of the life time, and point-by-point mapping of the local photo-electric response

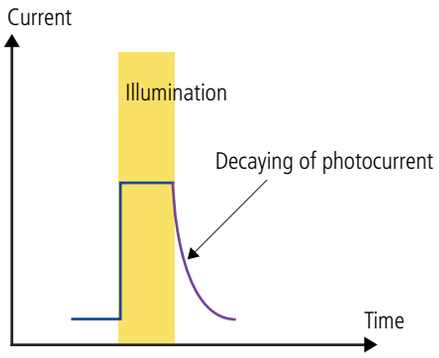


Figure 1 (a). A typical photocurrent response to a time-resolved illumination. The current between the sample and a voltage-biased cantilever is measured before, during, and after the illumination.

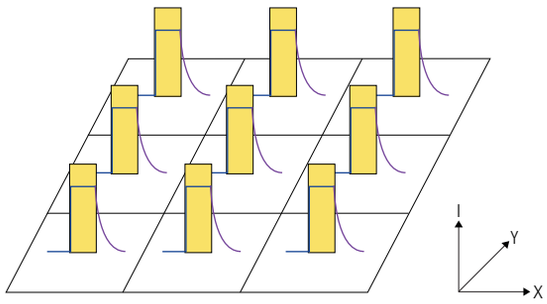


Figure 1 (b). Point-by-point mapping of photocurrent spectroscopy. Photocurrent response in time domain is acquired in each grid point defined on a sample.

Advanced Conductive-AFM and I/V Spectroscopy

AFM enables measurement of various local properties of samples in nanoscale; one of its great use is its ability to measure local conductance, acquired by placing a biased cantilever on the sample surface. The current between the two can be as low as a few pA, which requires sub pA current noise reduction. With the XE-Series, Park Systems offers the state-of-the-art conductive AFM options, which can detect current signal from mA to sub pA. With the remarkably low noise performance, the minute changes in sub pA are detected in the I/V curves of VLSI contact plugs (Figure 2).

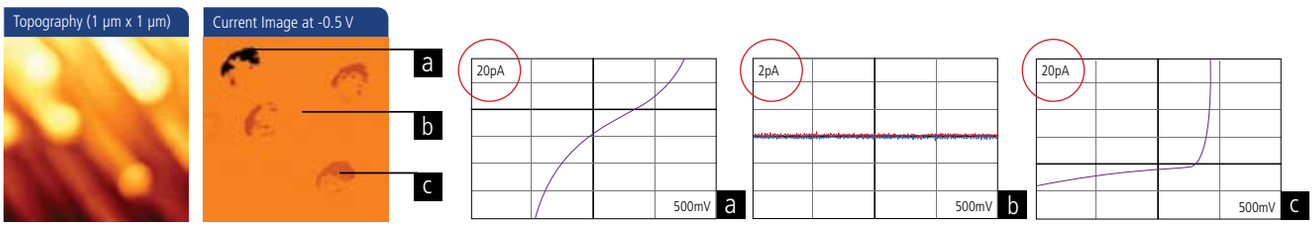
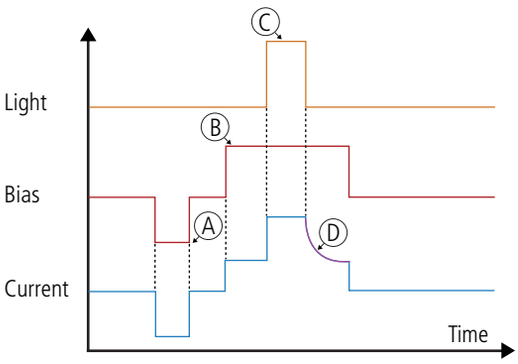


Figure 2. Topography, Current Image and I-V Curves of VLSI Contact

Time-Resolved Photocurrent Mapping

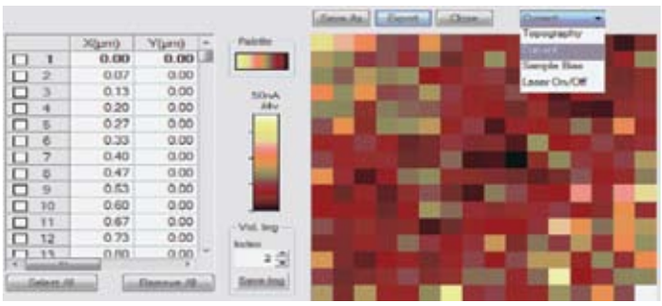
Tr-PCM measurement sequence



With all the light sources turned off, including the AFM's feedback laser, a reset voltage is applied to clear residual charges in photo-sensitive samples [A]. After applying the bias voltage [B], a photoelectric current is measured during a time-resolved illumination [C], which is followed by the measurement of the photocurrent decay after the illumination is switched off [D].

Figure 3. The measurement sequence of Time-resolved Photocurrent Mapping

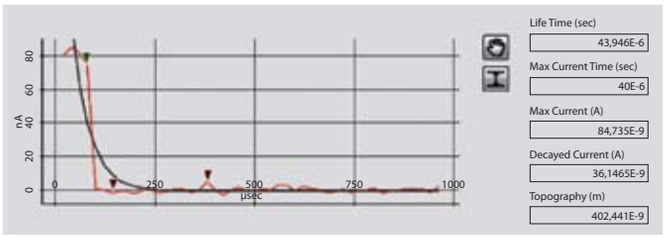
Simultaneous Acquisition of Topography and Time-resolved Photocurrent



Combined with high-speed and low-noise acquisition of electric currents, the Tr-PCM enables the point-by-point mapping of excitation life-times, hence resolving the spatial variation of photoelectric properties within a photo-sensitive sample.

Figure 4. Photocurrent responses on different sample points are being measured by the Tr-PCM.

Dedicated and Automated Analysis of Photocurrent Spectroscopy



The dedicated user interface allows the automated analysis and calculation of the excitation life-time. In Figure 5, the change of photocurrent on a given sample point is plotted with the life time of photocurrent excitation displayed on the right side.

Figure 5. From the photocurrent spectroscopy data, the life time of the photocurrent excitation is analyzed automatically.

Specifications

Mapping image	up to 256 x 256 points
Time resolution	20 µsec
Illumination intensity	0 to 100 % of 3 mW laser (at 550 or 650 nm)
Acquisition noise level of the electric current	< 1 pA (depending on the gain)
Bias voltage range	0 to 10 V (0.1 mV increment)
Data Export	ASCII Format