An STM – SEM setup for characterizing photon and electron induced effects in single photovoltaic nanowires

Objective

To present a technique where a scanning tunneling microscope (STM) probe inside an SEM is used to characterize single as-grown photovoltaic nanowires. Through this method, electrical, photovoltaic and strain-induced properties of individual as-grown semiconductor nanowires for solar cells can be studied simultaneously, with high-resolution imaging of the structures.

Sample Preparation

The investigated GaAs nanowires were grown vertically on a p-doped Si substrate by a self-catalyzed molecular beam epitaxy (MBE) method. The nanowire sample was mounted in front of the probe tip and the growth substrate was electrically connected to an external measurement circuit containing a picoammeter and a variable voltage supply, enabling I-V measurements. The probe was connected to the external circuit via the probe holder. A white LED was mounted on the STM-SEM holder to serve as the illumination source for the measurements involving light.

Data acquisition

There was used an STM-SEM sample holder fabricated by Nanofactory Instruments AB. The STM probe consisted of an Au-wire with a diameter of 0.25 mm. The holder with the LED was placed inside the vacuum chamber of a Zeiss Ultra 55 field emission gun SEM.

Representative figures & Results

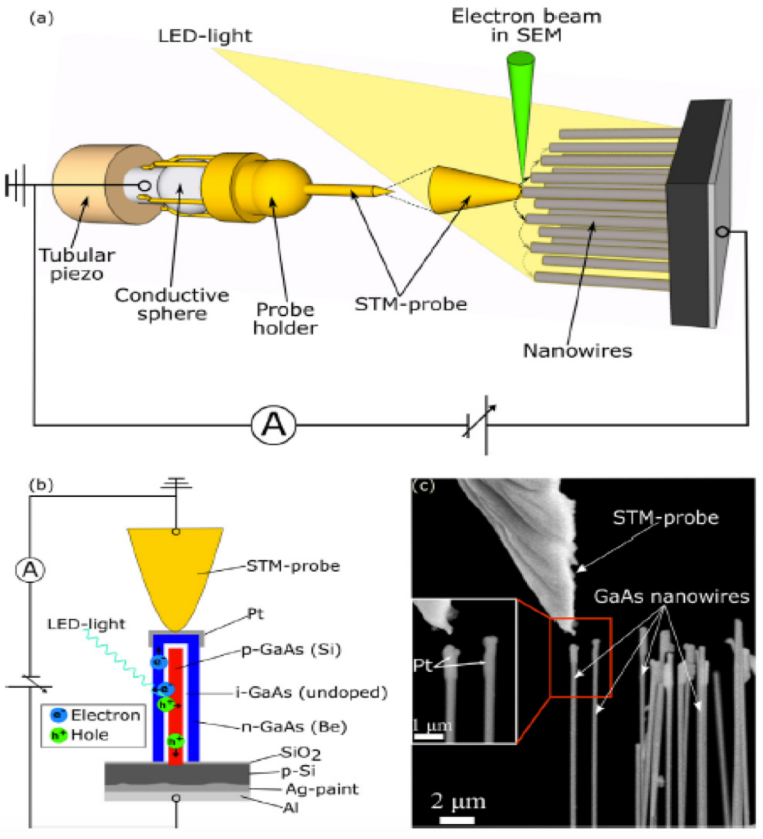

Fig. 1. Illustration of the STM-SEM technique.

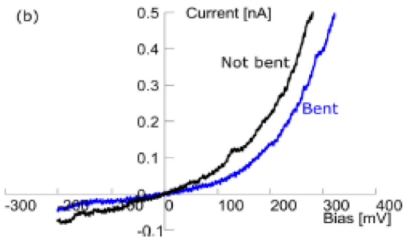

Fig. 3. SEM image showing how the STM probe can be used to bend a nanowire.

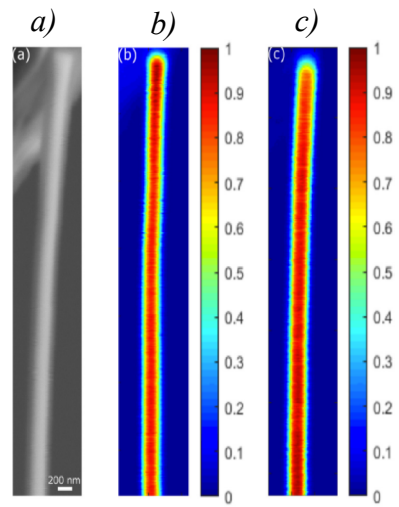

Fig. 4. (a) SEM micrograph of a nanowire contacted by the STM-probe and corresponding normalized EBIC maps at a beam acceleration voltage of (b) 20 kV and (c) 5 kV

Conclusion

This technique enabled the comparison of the performance of single nanowires, that were part of a nanowire ensemble, and correlated it to the nanowire structure. It was also possible to apply strain to the nanowires while performing measurements. Therefore, it provided useful information for understanding the effects of microscopic structure on the photovoltaic properties and improving the performance of nanowire-solar cells.