Sharp GaN Nanowires on the Si-Tip of active cantilevers for fast-AFM and Scanning Probe Lithography Applications

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The technological development of AFM systems is strongly connected to the performance of the cantilever. These probes evolved itself from a simple passive deflection element to a complex MEMS system through integration of functional groups, such as piezoresistive detection sensors and bi-material based actuators (Fig. 1). By using active cantilevers, direct patterning on Calixarene is demonstrated employing a direct, development-less phenomena triggered by tip emitted low energy (<75eV) electrons. The scanning probes are not only applied to the metrology, but also to micro and nano lithography and in the near future to Near Field Optical Microscopy.

Here we show actual trends and developments of miniaturization efforts of fabrication of active cantilevers with mounted sharp GaN Nanowires (NWs) using a focused ion beam (FIB). GaN NW used as tip of an active cantilever offer a number of merits like (1) the reduction of tip-dimensions due to the robust mechanical properties of the GaN; (2) perfect control of the AFM tips geometries at the atomic level thanks to the nano fabrication of single crystal NWs which lead to control scanning artifacts (3) controlling the conductivity of GaN NWs tips by doping concentration during growth.

Single crystal GaN NWs were grown by Metal Organic Chemical Vapor Deposition (MOCVD). Fig.2 shows tip fabrication procedure, where an omniprobe is employed to transfer sharp GaN NW from initial substrate to a flattened Si cantilever. In the transfer process, first a Si cantilever is flattened by ion beam, then, a NW is detached from its substrate by means of an omniprobe and transferred to position on the flattened cantilever. The NW is welded by Pt deposition to stabilize tip for scanning.

We will present results about the application of these GaN tips for atomic force microscopy (fig. 3) and field emission lithography. Improvement of image quality, tip stability and lithographic resolution will be discussed.

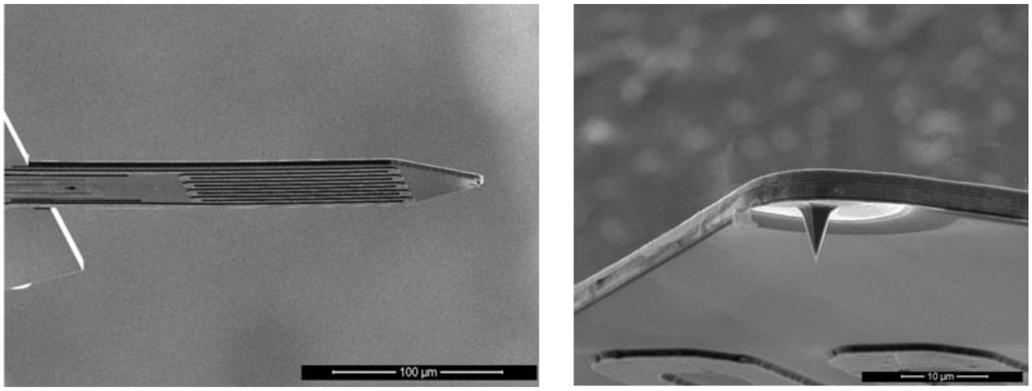

Fig .1. Standard active cantilever from nano analytik GmbH.

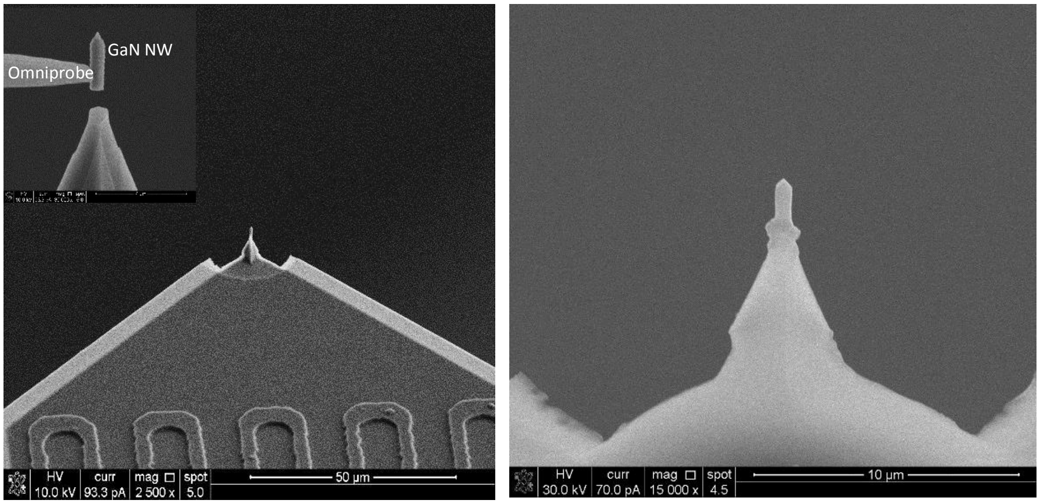

Fig. 2. (a) Mounting GaN NW on Si cantilever. Inset shows NW transferring using omniprobe. (b) Zoom-in SEM image of a fabricated tip using FIB technique.

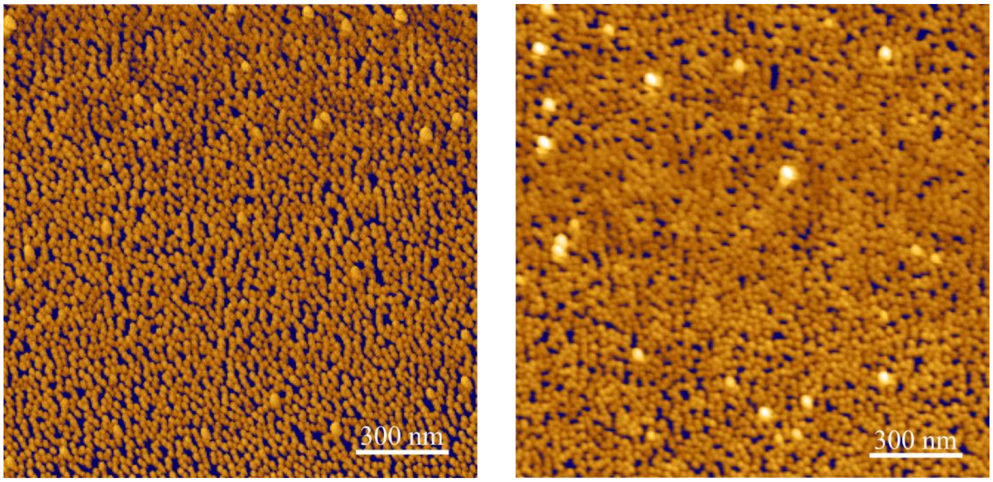

Fig. 3. Two non-contact AFM topographical images of a nano-textured Al2O3 sample exhibiting an improvement of the resolution at the same scanning conditions (1028pixels with 25 lines/sec). (a) NA-active cantilever with GaN tip; (b) standard Si cantilever from NA. Images were taken with a nanoMETRONOM AFM system from Nano Analytik GmbH using NA-operating software's non-contact high speed mode.