Field Emission Scanning Probe Lithography with GaN nanowires on active cantilevers

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Field emission scanning probe lithography (FE-SPL), is based on the exposure with low energy electrons emitted from ultra-sharp tip placed in close vicinity to a resist-covered substrate. FE-SPL has significant benefits over traditional e-beam lithography including (i) closed-loop operation; (ii) improved lateral resolution; (iii) lower implementation cost; (iv) ambient or vacuum operation capability; (v) a simplified means of delivering exposure electrons without column or electron optics requiring optimization; (vi) high-overlay accuracy and stitching; and (vii) the ability to "write and read" with the same probe in a nondestructive and cost-effective manner including mix-and-match lithography for high throughput [1]. The technological development of SPL systems is also strongly connected to the performance of the cantilever and the quality of the tip. Last year we presented our efforts in fabrication of active cantilevers with mounted sharp GaN nanowires [2]. We have already shown that GaN NWs have superior mechanical properties compared to the conventional Si-based tips which makes them an excellent candidate for scanning probe microscopy [3, 4]. Having tunable conductivity due to the controlled doping concentration, GaN NWs can be also employed in SPL.

In this study, ultra-sharp GaN NWs are fabricated through a bottom-up approach in a metal-organic chemical vapor deposition (MOCVD) reactor by growing six semipolar planes on the top of c-plane GaN pillars [figure 1(a)]. These NWs are mounted onto the Si-tip by using an omniprobe needle in a SEM/FIB instrument [figure 2 (b)] [5]. Our results show that GaN tips exhibit a higher mechanical stability than the typically applied silicon, which is supposed to increase tip lifetime and reproducibility of the lithography process. Furthermore, offers a high chemical stability, whereas electrical and optical properties of GaN are tunable. In this work we will present long time exposure results using GaN

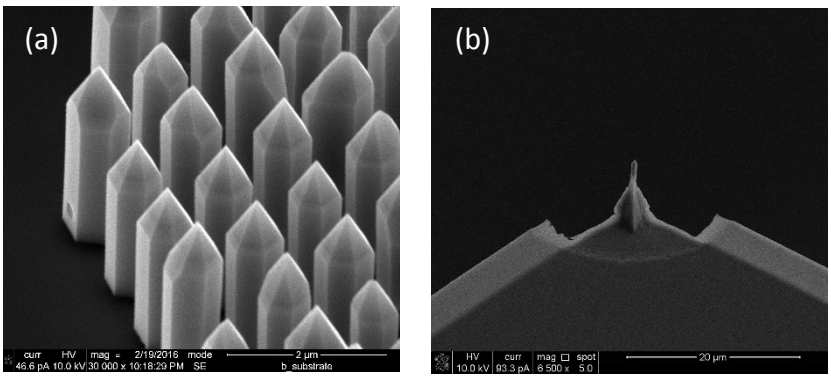

Figure 1. (a) Ultra-sharp GaN NWs. (b) Mounted Gan NW on a Si cantilever.

nanowires tips, mounted on active scanning probes as field electron emitter. We will present also a systematic study of the field emission current stability, exposure reproducibility, and results on exemplary high resolution exposure and imaging using the same GaN tips.

References

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