High Aspect Ratio GaN Nanowires for Tip Metrology and Optical Application

M. Behzadirad, M. Nami, D. Feezell, T. Busani[+]
Center for High Technology Materials, University of New Mexico, Albuquerque, NM 87106, USA

GaN has recently received many attentions for their specific optical properties as a wide band gap semiconductor. GaN, in form of single crystal NWs, is taking an important role in future optoelectronic devices as they can increase surface to volume ratio of the active region and enhance the device efficiency [1, 2]. Since the quality of the NWs after growing determine the efficiency of the final device operation, many researches have been devoted to grow high quality NWs [1, 2, 3]. Bottom-up approach has been employed to acquire desire NWs since late 1990s [3], however, it is difficult to control growing parameters in Molecular Beam Epitaxy (MBE) or Metal Organic Chemical Vapor Deposition (MOCVD), and so the fabrication process is complex and expensive. Likewise, growing high aspect ratio NWs with small diameter (<100 nm) is always challenging. On the contrary, top-down approach has demonstrated promising results in creating high aspect ratio structures as an alternative method for NWs fabrication. However, emerging roughness in side wall of the NWs and as a result poor optical property of the device has been an issue in top-down process which hindered wide application of this cost-effective method in device fabrication. Here, we demonstrate two-step (dry-wet etch) top-down fabrication of high aspect ratio (10-18) single crystal GaN NWs with side wall of sub-nanometer roughness. Two methods are employed to inspect NW side wall quality: i) TEM imaging, and ii) optically pumping of NWS. All NWs with different aspect ratio demonstrated very smooth side wall on TEM imaging as well a sharp lasing peak at ~367 nm when they are pumped with 266 nm laser. We also demonstrate how fabricated NWs can outperform standard Si tip in Atomic Force Microscopy, and potentially create more effective optoelectronic devices as they have less roughness compared to other reported works using the same growing method.

[+] Author for correspondence: Tito Busani, busanit@unm.edu

[1] Li et al, optics express, 19, 25528(2011).
[2] Li et al, optics express, 20, 17873(2012).
[3] Yoshizawa et al, JJAP, 36, 49 (b) (1997).