An alternative path for the fabrication of self-assembled group III-nitride nanowires

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III-nitride alloys are the key materials for the future high-power, efficient, and reliable photovoltaic systems. Their large band-gap tunability covers wavelengths ranging from infrared (~0.7eV/InN) up to ultraviolet (6.2eV/AlN), making them ideal candidates for a broad range of optoelectronics applications. Rapid progress during the last decade in nanostructure processing allowed significant boost of optoelectronic device performance. Nevertheless, production simplicity and low production costs remain crucial requirements for successful broad industrial application. To this end, the combination of self assembled nanowire formation with low cost substrates may open new routes to tackle these demands.

Here, we introduce an alternative dry etching fabrication procedure for defect-free NW formation from planar III-nitride layers grown by metal-organic vapor phase epitaxy (MOVPE). The technique is based on fully *non-lithographical processing* with similarities to the fabrication of so called black Si [1,2]. Applying a *reactive ion etching (RIE)* process to group III-nitride films using a combination of radio frequency power (120 W) and a high inductively coupled plasma power (2500 W) with a chlorine/argon gas mixture leads to dense arrays of nanowires (NWs). The structural properties of the as such fabricated nitride NWs were investigated by high resolution transmission electron microscopy (HRTEM) and μ-Raman backscattering. Photoluminescence (PL) measurements were carried out from 289 K to 4 K. The characteristics of the nitride NW are compared to those of the layers from which they were fabricated. Photoluminescence studies show an increase of the photoluminescence efficiency in the RIE processed NWs in comparison to their layer counterpart, which can be interpreted as preferential etching of structural defects existing in layers. Indeed, the HRTEM investigations show a high crystalline quality and no dislocations within the nanowires. Analyzing μ-Raman scattering data from n-GaN NWs in comparison to planar films indicate an increased electron concentration in the NWs (n=3-4x 10^{17} cm^{-3}) and a mobility of μ ~ 100 $cm^2V^{-1}s^{-1}$.

Our data suggest that RIE of unmasked III-nitride MOVPE films may be a viable route for the massproduction of nitride nanowires of pristine quality suitable for sensing, light emitting and photovoltaic applications.

[1] M. Gotza, B. Saintcricq, M. Dutoit, Ph. Jouneau, *Microelectr. Engineer*. **27**, 129 (1995)
[2] A. Haab, M. Mikulics, A. Winden , 2012, *Phys. Stat. Sol. A* **209** 443-446.