FABRICATION OF NANOPERFORATED GaN NANOMEMBRANES

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Abstract. We report on fabrication of suspended ultrathin GaN membranes nanoperforated in an ordered fashion using direct writing of negative charges by focused ion beam and subsequent photoelectrochemical etching of the GaN epilayers. Recent studies show that GaN is biocompatible and non toxic material and could be considered for biomedical implants [1]. Possessing piezoelectric and easy adaptable for wireless technology it becomes a good candidate for implantable biosensors for monitoring of biological processes. Nanostructured materials have an incredible high surface to volume ratio. The high specific surface of GaN nanostructures could affect cells behavior [2].

The realization of reliable ultrathin GaN membranes with designable nanoarchitecture still remains a major technological challenge. In this paper, we demonstrate the applicability of SCL [3] for the fabrication of nanoperforated GaN ultrathin membranes with a regular arrangement of holes. Along with this, we present the results of a comparative analysis of persistent photoconductivity (PPC) and optical quenching (OQ) effects occurring in continuous and nanoperforated ultrathin GaN suspended membranes, and assess the mechanism behind these phenomena.

Figures 1 a, b illustrate SEM images of a suspended nanoperforated membrane. The diameter of the holes in the perforated membrane equals 270 nm, while the thickness of the walls separating two neighboring holes is about 80 nm. The thickness of the membrane is estimated to be ~ 15 nm that correlates with the projected range of 30-keV Ga^+ ions in the GaN matrix. The insert in Fig. 1b shows a pan-chromatic micro-CL image of the nanoperforated membrane which demonstrates the occurrence of yellow luminescence observed at ~2.15 eV and associated with defects in the membrane. Note the intense UV luminescence stemming from the etched GaN layer underneath.

Surface charge lithography is demonstrated to be an efficient tool for maskless material nanoperforation that adds an additional degree of freedom to controlling the photoelectric properties of suspended ultrathin GaN membranes. The developed cost-effective ordered nanoperforation of GaN membranes is promising for many applications in electronics, photonics, and biomedicine, chemical and bio-chemical sensors.

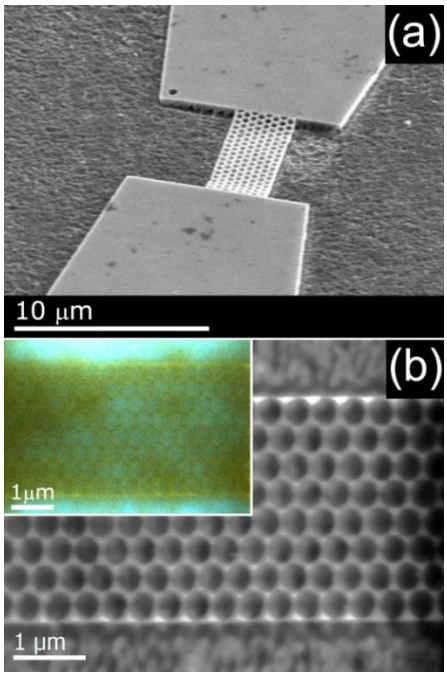

Figure 1. SEM images taken from a suspended nanoperforated GaN membrane produced by SCL: oblique (a) and top (b) views.

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