Metal catalyzed porous n-type GaN layers: low resistivity ohmic contacting and single-step MgO/GaN diode formation

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Gallium nitride (GaN) is considered one of the most important wide band-gap semiconductors for a number of applications in electronics and optoelectronics[1]. In its porous form, GaN has received particular interest in the last decade due to beneficial optical and electronic properties for gas sensors with high sensitivity, and light-emitting diodes (LEDs) with high light extraction efficiency[2]. Porous GaN has been typically fabricated by (photo)electrochemical and chemical etching methods, giving textured surfaces as a result of pore coalescence and variations in etch rates for extended etching times.

We produced porous GaN through the direct reaction of metallic Ga with NH_3 in a simple chemical vapor deposition system[3]. We deposited micrometer size nanoporous GaN particles directly onto silicon substrates using this technique without necessitating any secondary etching or chemical treatment after growth to induce porosity.

Porous GaN crystals have been successfully grown and electrically contacted simultaneously on Pt- and Au-coated silicon substrates as porous crystals and as porous layers. By the direct reaction of metallic Ga and NH_3 gas through chemical vapor deposition, intermetallic metal-Ga alloys form at the GaN-metal interface allowing vapor-solid-solid seeding and subsequent growth of porous GaN. Current-voltage and capacitance-voltage measurements confirm that the intermetallic seed layers prevent interface oxidation, and give a high quality reduced workfunction contact that allows exceptionally low contact resistivities. Additionally, the simultaneous formation of a lower workfunction intermetallic permits ohmic electron transport to n-type GaN grown using high workfunction metals that best catalyze the formation of porous GaN layers and may be employed to seed and ohmically contact a range of III-N compounds and alloys for broadband absorption and emission.

When doping these nanoporous GaN with a high concentration of Mg using Mg_3N_2 as precursor, a layer of crystalline MgO is formed in between the Au- or Pt-electrode and nanoporous GaN. Charge transport measurements through this system were conducted using 2- and 4-probe measurements and confirm the fabrication of a porous GaN diode with an *in-situ* grown crystalline MgO high-k dielectric layer.

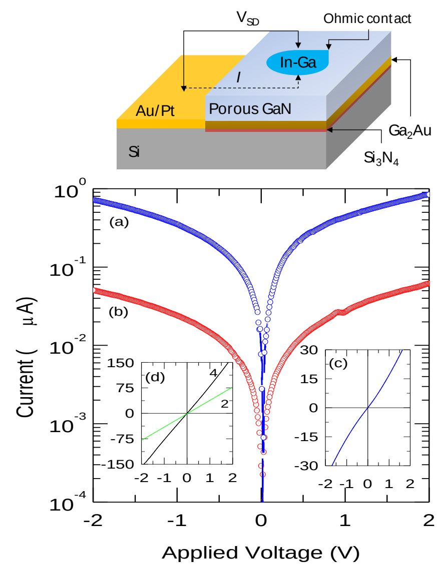

Fig. 1. (Top) Schematic of the contacted porous GaN layer. (Bottom) ln(*I*)-*V* curves for porous GaN grown from (a) Pt and (b) Au. (c) *I-V* curve for the porous GaN grown directly from Pt and (d) *I-V* curves from 2- and 4-probe measurements using In-Ga ohmic contacts to porous GaN.

References

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