SPIE Photonics West, San Francisco, CA, USA, 27 January - 1 February 2018
Conference OE126 "Light-Emitting Diodes: Materials, Devices, and Applications for Solid State Lighting XXII".

3D device processing of GaN nanostructures for electronic and optoelectronic sensor platforms

Hutomo Suryo Wasisto[1,*], Jan Gülink[1,2], Shinta Mariana[1], Steffen Bornemann[1,2], Nursidik Yulianto[1,3], Feng Yu[1], Klaas Strempel[1,2], Muhammad Fahlesa Fatahilah[1], Tony Granz[1], Nicolai Markiewicz[1,4], Daria Bezshlyakh[1], Gregor Scholz[1], Iqbal Syamsu[1,5], Heidi Boht[1], Jana Hartmann[1,2], Sönke Fündling[1,2], Bernd Witzigmann[6], Joan Daniel Prades[4], Martin Strassburg[7], Hans-Jürgen Lugauer[7], Andreas Waag[1,2]

[1] Institute of Semiconductor Technology (IHT) and Laboratory for Emerging Nanometrology (LENA), Technische Universität Braunschweig, 38106 Braunschweig, Germany
[2] Epitaxy Competence Center (ec[2]), Technische Universität Braunschweig, 38106 Braunschweig, Germany
[3] Research Center for Physics, Indonesian Institute of Sciences (LIPI), 15314 Tangerang Selatan, Indonesia
[4] MIND-IN2UB, Department of Engineering - Electronics, University of Barcelona, 08028 Barcelona, Spain
[5] Research Center for Electronics and Telecommunication, Indonesian Institute of Sciences (LIPI), 40135 Bandung, Indonesia
[6] Computational Electronics and Photonics, University of Kassel, 34121 Kassel, Germany
[7] OSRAM Opto Semiconductors GmbH, 93055 Regensburg, Germany

* E-mail: h.wasisto@tu-braunschweig.de; Phone: +49 531 391 3167

250-word text abstract for technical review purposes that is suitable for publication

GaN nanostructures with vertical 3D architecture, well-designed geometry, high aspect ratio, and large area coverage have been continuously developed as an alternative path towards novel nanodevices for enhanced multiple optoelectronic and electronic sensor systems. Such building blocks offer large surface-to-volume ratio, high-quality material (i.e., almost defect-free), non-polar surface orientations, and feasibility to use enormous area foreign substrates without devising strain. All these unique characteristics are difficult to be obtained in planar thin film approaches. To manufacture 3D GaN nanoarrays, both bottom-up and top-down approaches involving different nanolithography techniques (i.e., photolithography, nanoimprint lithography, nanosphere lithography, and e-beam lithography), can be employed offering homogeneous size distribution and fine morphology. However, 3D processing is still a major challenge. Here, we report on the further development of 3D processing towards biomedical/chemical sensors and vertical field-effect transistors (FETs). In terms of the geometry, nanofins potentially provide more benefits than vertical nanowires as they can reduce edge effects, have a higher gain in effective surface area, and be more accessible for material analysis. The talk will focus on the comparison of direct bottom-up MOCVD growth with top-down hybrid etching results, with particular highlight on the subsequent 3D processing. The performance of 3D micro-/nanoLEDs and vertical FETs as well as their integration into sensor devices for different applications will be presented and discussed.

100-word text summary suitable for early release

GaN nanostructures with vertical 3D architecture, well-designed geometry, high aspect ratio, and large area coverage have been continuously developed as an alternative path towards novel nanodevices for enhanced multiple optoelectronic and electronic sensor systems. Such building blocks offer large surface-to-volume ratio, high-quality material (i.e., almost defect-free), non-polar surface orientations, and feasibility to use very large-area foreign

substrates without devising strain. To manufacture the 3D GaN nanoarrays, both bottom-up and top-down approaches involving different nanolithography techniques can be employed offering homogeneous size distribution and fine morphology. Additionally, 3D processing has been successfully developed to realize biomedical/chemical sensors and vertical field-effect transistors.