

Ultra-Wide-Bandgap Aluminum Gallium Nitride (UWBG) Power-Conversion and Radio-Frequency Applications

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Abstract

Wide-Band-Gap (WBG) Gallium Nitride channel lateral High Electron Mobility Transistor (HEMT) devices emerged as one of the top contenders for high-voltage RF and power conversion application areas. This is due to the high mobility of the 2DEG channel, and most importantly a large critical electric field (E_{crit}) allowing high voltage operation. Since E_{crit} is related to the band-gap by roughly square-law relationship, the Ultra-Wide-Band-Gap (UWBG) Aluminium Gallium Nitride (AlGaN) materials and devices hold the promise to surpass the performance of the WBG materials in the high voltage application arena [1].

High critical field enables either higher voltage and power, or higher power density without impacting reliability. The Unipolar Figure of Merit (FOM), a measure of the trade-off between breakdown and on-resistance is proportional to the product of the mobility and the 3rd power of E_{crit} and thus depends strongly on E_{crit} . Similarly, the Johnson FOM, a metric for RF operation, is proportional to the saturation velocity and E_{crit} . Hence, in both measures, performance is expected to improve with UWBG materials, provided that the mobility

and the saturation velocity do not degrade appreciably.

In this talk, an overview of UWBG Al-rich AlGaN device research at SNL will be presented. Mobility in Al-rich AlGaN channel devices is alloy-scattering limited and relatively temperature insensitive and is thus promising for high-temperature applications. Recent progresses on ohmic contact formation on Al-rich AlGaN will also be presented [2].

SNL is managed and operated by NTESS under DOE NNSA contract DE-NA0003525.

[1] J. Y. Tsao et al., Adv. Elec. Mat. Adv. Elec. Mat. 4, 1600501 (2018)

[2] B. A. Klein et al., ECS J. Solid-State Sci. Tech. 6 (11), S3067 (2017)

Biography

Shahed Reza is a principal member of technical staff at Sandia National Laboratories, where he is currently leading research activities on physics-based device and subsystem modelling methodologies. Dr Reza received his PhD in Electrical Engineering from University of Florida and he has held several R&D positions in the industry. He has eight US patents and over 60 technical publications in peer reviewed journals and conferences.