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Development of TaC substrates for AlGaN power electronics

Performance of UWBG materials for vertical high-power, high-frequency electronics is characterized by the Baliga FOM which is a measure of power handling, a cubic function of critical electric field. Further scaling of power handling to 106x compared to the industry workhorse Si is limited by the availability of conducting lattice matched substrates. Conventional substrate materials that can be grown in bulk are either lattice mismatched to the best-known active layers (e.g., Al2O3 is lattice mismatched for AlGaN), lack a good combination of electrical and thermal properties (e.g., Ga2O3), or are cost prohibitive (e.g., diamond). High electrical and thermal conductivity of the substrate leads to improved device functionality and reliability with lower electrical losses, higher switching frequencies, and more robust performance under extreme conditions. We will discuss how the power handling of Al0.7Ga0.3N (001) devices on lattice matched TaC (111) with measured resistivity ~200Ω «10Ω for SiC substrates could lead to 100X power handling compared to similar GaN/SiC devices. We show rectification in lattice matched AlGaN/TaC Schottky diodes with measured critical fields >4MV/cm higher than GaN/SiC. Use of TaC substrates could enable thick unstrained AlGaN drift layers to be realized for high voltage devices >3kV and high current handling >10kA/cm^2.

Academic or Professional Status

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