Laser-Based Annealing of Nickel Contacts for SiC Devices: Towards Thermally Robust Power Interfaces in 3D-Integration

Clair, Maurice[a]

[a] *3D-Micromac AG, Technologie-Campus 8, 09126 Chemnitz. Germany*

Thermal management and electrical integrity pose significant challenges in 2.5D and 3D packaging, particularly for wide-bandgap semiconductors such as silicon carbide (SiC), which enable advanced, power-dense systems in automotive and high-performance computing applications. Consequently, Ohmic contact formation (OCF) for SiC must advance beyond traditional rapid thermal processing (RTP) to address the requirements of thinner substrates, lower thermal budgets, and increased integration density.

This study investigates a laser-based method for localized OCF on SiC, utilizing diode-pumped solid-state lasers (DPSSLs) at ultraviolet wavelengths. The effects of laser fluence, pulse duration, and beam overlap on the formation of nickel silicide (NixSiy) contacts on 350 µm-thick 4H-SiC wafers with 70 nm NiAl metallization are systematically examined. Qualitative process trends are established using structural, electrical, and chemical performance indicators, with particular attention to the suppression of carbon-rich interfacial layers, which are critical for interface reliability under elevated thermal and electrical stress.

The principal findings of this investigation are summarized as follows:
(1) Laser-based Ohmic contact formation enables electrically stable contacts at high laser fluences, demonstrating both robustness and process tolerance;
(2) Laser energy density predictably determines the thickness and uniformity of nickel silicide (NixSiy) layers;
(3) Reducing pulse overlap to below 30% minimizes carbon accumulation at the metal/SiC interface.

This laser-driven technique offers a promising alternative to RTP, especially for localized processing and reduced thermal budgets. By minimizing global substrate heating and enhancing interface stability, this approach improves thermal integration compatibility for SiC-based power devices in 2.5D and 3D packaging environments.

* *corresponding author e-mail:* clair@3d-micromac.com