World Academy of Science, Engineering and Technology
International Journal of Electrical and Computer Engineering
Vol:19, No:01, 2025

Device-integrated Micro-thermocouples for Reliable Temperature Measurement of GaN HEMTs

Authors : Hassan Irshad Bhatti, Saravanan Yuvaraja, Xiaohang Li

Abstract : GaN-based devices, such as high electron mobility transistors (HEMTs), offer superior characteristics for high-power, high-frequency, and high-temperature applications [1]. However, this exceptional electrical performance is compromised by undesirable self-heating effects under high-power applications [2, 3]. Some of the issues caused by self-heating are current collapse, thermal runway and performance degradation [4, 5]. Therefore, accurate and reliable methods for measuring the temperature of individual devices on a chip are needed to monitor and control the thermal behavior of GaN-based devices [6]. Temperature measurement at the micro/nanoscale is a challenging task that requires specialized techniques such as Infrared microscopy, Raman thermometry, and thermoreflectance. Recently, micro-thermocouples (MTCs) have attracted considerable attention due to their advantages of simplicity, low cost, high sensitivity, and compatibility with standard fabrication processes [7, 8]. A micro-thermocouple is a junction of two different metal thin films, which generates a Seebeck voltage related to the temperature difference between a hot and cold zone. Integrating MTC in a device allows local temperature to be measured with high sensitivity and accuracy [9]. This work involves the fabrication and integration of micro-thermocouples (MTCs) to measure the channel temperature of GaN HEMT. Our fabricated MTC (Platinum-Chromium junction) has shown a sensitivity of 16.98 µV/K and can measure device channel temperature with high precision and accuracy. The temperature information obtained using this sensor can help improve GaN-based devices and provide thermal engineers with useful insights for optimizing their designs.

Keywords : Electrical Engineering, Thermal engineering, Power Devices, Semiconuctors
Conference Title : ICCEE 2025 : International Conference on Computer and Electrical Engineering
Conference Location : Dubai, United Arab Emirates
Conference Dates : January 30-31, 2025