

Title III Gallium Nitride (GaN) on Silicon Carbide (SiC) X-band MMIC Production

Joseph Smolko
Colin Whelan
Christopher Macdonald
Joshua Krause
Bradley Mikesell
Michael Benedek
all of Raytheon Company

Abstract

This 3+ year Title III program fabricates over (200) 100 mm GaN SiC wafers to establish a domestic, economically viable production capacity for 28 Volt, X-Band Monolithic Microwave Integrate Circuits (MMICs) with a goal of achieving MRL 8. Raytheon has demonstrated all the objective metrics for the program and expects to validate MRL 8 shortly.

Summary

The Raytheon Team started work on this Title III program late in 2009. The goal of the program was to optimize Raytheon's production released coplanar waveguide (CPW) GaN MMIC process to MRL 8 by the end of the program in support of multiple future DoD system insertions from L-band through Ku-band. Key Performance parameters (KPPs) defined the quantitative program goals; threshold levels being minimally acceptable and objective levels reflecting the maturity, yield and robustness of established semiconductor technologies. The technical portion of the program is comprised of three major tasks:

- **Baseline MRL assessment:** Process 24 wafers with the baseline production process and evaluate yield and reliability
- **Process centering and tightening:** examine shortfalls in the baseline process, analyze root cause and identify a series of experiments to improve the process. Process a minimum of 150 process improvement wafers during this task. Monitor yield improvement and reliability throughout this task.
- **Final MRL assessment:** Process 24 wafers with the improved process and verify that KPPs have been achieved and the process is at MRL 8

At the completion of the process centering and tightening, Raytheon demonstrated that the objective KPPs were achieved and demonstrated significantly improved producibility and process maturity (Table 1).

Table 1. Highlights of progress on Raytheon's Title III Gallium Nitride (GaN) on Silicon Carbide (SiC) X-band MMIC Production Program

| Parameter | Progress Highlights | Comments |
|----------------------|---|---|
| Product Yield | Comparable to mature GaAs process | X-band Power amplifier |
| Cost | significantly lower cost in \$/W relative to GaAs | Improved Yield, Streamlined Process, Supplier Relationships |
| Reliability - DCTALT | Better reliability than GaAs | Improved Process, Optimized Screening, High temperature fixturing |
| Reliability - RFOL | Flat and steady Pout; equivalent to GaAs | Improved Process, Optimized Screening |