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Application Note

k-Space Associates, Inc

Laser Reflectance Solution for Older CCS MOCVD Systems

REAL-TIME MONITORING

- **Complex rotational gearing problems now solved for in-situ monitoring**
- **Growth rate**
- **Layer thickness**
- **Optical constants (n,k)**
- **Roughness**
- **True Real-time fitting**
- **Unmatched S/N using high power 532nm laser**
- **Detect 0.01 % changes in reflectivity**
- **Successful GaN Device results**
- **Multi-wafer software available**
- **Simple setup and alignment**

Introduction & Motivation

Many of today's optoelectronic and high-speed electronic device materials are epitaxially grown with advanced MOCVD systems originally manufactured by Thomas Swan Scientific Equipment (TSSE, now part of the Aixtron MOCVD group). These systems had complex, non-integer, rotational gearing ratios which made accurate in-situ monitoring during growth impossible. The ability to synchronize data acquisition during growth on these systems has been limited until now. K-Space has developed a solution for integrating kSA RateRat 532nm laser-based reflectivity system onto these the CCS MOCVD systems for real-time growth monitoring. This now paves the way for utilizing reflectivity based in-situ monitoring, a proven and indispensible tool for real-time monitoring of thickness, growth rate, optical constants (n,k), and surface roughness.

Figure 1: kSA RateRat Pro installed onto multi-wafer TSSE CCS MOCVD System

Solving Complex Rotational Gearing for Data Synchronization

The kSA RateRat system was modified to handle a non-integer gear ratio (42:16 or 21:8 wafer carrier:encoder) on the TSSE close-coupled showerhead reactor. To implement this change, both electronics rack wiring and new software was developed. The new software implementation involved a countdown timer which would generate soft resets in between the 21 countdown (encoder)/ 8 carrier hard reset home pulses. For flexibility, the software is also configurable for user input of the gear ratio, as well as whether or not to generate soft resets in between the hard home pulse reset.

By using a standard oscilloscope and looking at the ratio of home pulse frequency to encoder pulse frequency (both coming from encoder), it was determined that the encoder being used on the TSSE reactor is a 1000 pulse/revolution encoder. Therefore, the 21:18 gear ratio (2.625) means that there are 2625 encoder pulses per wafer carrier rotation. This number is entered into the "total encoder pulses" textbox of software. A "Max number of positions" parameter is also entered into the software to address the case when the divide down number does not result in a whole number for home sensing. By combining the integrating kSA RateRat with advanced real-time rotational synchronization algorithms, reflectivity data from single or multiple wafers can now be analyzed reproducibly with extremely high S/N. Thickness, Growth Rate, Optical constants (n,k), and roughness during initial buffer layer growth on sapphire, subsequent homoepitaxial growth of GaN, and active layer growth is shown in figure 2.

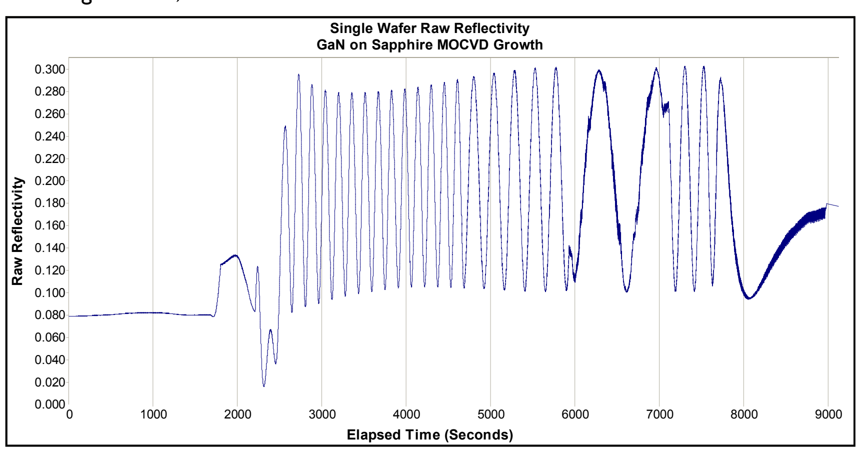

Figure 2: Single wafer kSA RateRat reflectance during GaN device Run