

# **RF Benchmarking and Evaluation Facility**

## **SUMMARY**

A facility has been developed to benchmark and evaluate radio-frequency (rf) components and systems used in material processing. Through a contract with SEMATECH, the facility was established to benchmark the components of the rf systems used in the plasma processing of microelectronics or any application that uses rf or microwave power (flat panel display manufacturing, radar, communications, etc.). Capabilities include the ability to evaluate all parts of the rf system, including the generator, matching network, sensors, and all connecting hardware. Individual components or subsystems can be evaluated using a consistent testing method, and the factors that influence unit to unit variance can be determined - a critical processing need for repeatability and reliability. Components are tested under full operating power and are exposed to a variety of operating conditions that are expected in the manufacturing line.

## **DESCRIPTION**

The facility has the capability to test and evaluate all parts of the rf system. Components are evaluated as a function of power, impedance, and frequency. Diagnostics include phase-locked network analyzers for impedance measurements, a vector spectrum analyzer for frequency and harmonic measurements, and calorimetry techniques combined with electrical techniques to give accurate and repeatable power measurements. A variety of surrogate loads to simulate a plasma are available, as well as an actual plasma load for some applications. Most evaluation is performed at 13.56 MHz or 2.0 MHz (and their harmonics), which are common industrial frequencies. Power is typically in the range of 100W to 1 kW, but some next generation processing tools will require up to 10 kW. Capabilities for the facility include frequencies from 0.1 MHz to 450 MHz and power ranges of up to 1.5MW. Microwave facilities are also available in the frequency range of 915 MHz to 53 GHz, with power of up to 200 kW.

## **APPLICATION FOR MILITARY PURPOSES**

The facility is applicable for a variety of military purposes, including radar, communications, and the manufacture of computer chips or flat panel displays used for military purposes. The facility has the ability to test and evaluate all components of a rf/microwave power delivery system, where the application can range from power going to an antenna for a radar/communications to a plasma for a material processing application used in making a computer chip/flat panel display. The facility has the ability to simulate the load impedance seen by a typical system, including linear and non-linear loads. Components of the system can be tested to determine power limitations as a function of load impedance and frequency. The benefits of this type of evaluation include the determination of power limitations, increased component lifetime/protection, increased component and system reliability, optimization of power coupling, and a decrease in system-to-system variance. Oak Ridge is recognized as a leader in rf/microwave expertise and technology for the semiconductor processing industry and in the international magnetic fusion effort. This facility has the broadest range of frequency, power, and diagnostic capability in the U.S.

