metric method provides a powerful direct approach for measuring mass distribution in polyethylene at a time of accelerated introduction of new molecular architectures. CONTACT: William Wallace, (301) 975-5886; william.wallace@nist.gov.

**NIST PERFORMS ELECTROMAGNETIC SHIELDING EFFECTIVENESS TESTS ON A COMMERCIAL AIRCRAFT**

NIST recently performed electromagnetic shielding effectiveness tests on a commercial aircraft using NIST designed broadband horn antennas and specialized time domain measurement methodology. The information gained in this effort is being used to develop low-cost and efficient measurement techniques for *in situ* testing of aircraft.

Shielding effectiveness measurements are performed to quantify the electromagnetic fields coupled into an aircraft from an external source, or conversely, internal to external coupling. It is best is to measure an aircraft at an open area test site. However, taking an aircraft out of the production chain is extremely costly for the aircraft industry. Continuous wave measurements made in a hanger or production facility suffer from unwanted reflections that make data interpretation difficult. Thus, the aircraft industry is interested in time domain methods that enable extraneous reflections due to hanger walls to be windowed out using gating techniques.

NIST engineers used time domain methodology developed at NIST to measure an aircraft in a paint hanger along the production line. In addition, NIST has developed a joint time-frequency analysis tool that will be used to extract critical cavity decay characteristics useful in aircraft shielding studies. The Naval Surface Weapons Center and a private company sponsor this effort.
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**NIST OPENS NEW SPECIAL TEST MEASUREMENT SERVICE FOR 2.92 mm COAXIAL POWER DETECTORS**

Staff at NIST recently opened a new Special Test Service for 2.92 mm coaxial power detectors. This new service measures the effective efficiency and calibration factor of thermistor, thin-film, and thermoelectric power detectors over a frequency range of 0.01 GHz to 40 GHz. Power measurements are basic to all measurements in the microwave and electronics industry.

In recent years, the instrument manufacturers have been moving to coaxial line sizes that operate at frequencies up to 40 GHz and beyond. A number of electronic instruments are now commercially available that have 2.92 mm coaxial connectors and that operate at frequencies up to 40 GHz. The new service will provide power measurement traceability for those devices. The power calibrations are made on the NIST direct comparison system. This system is calibrated using 2.4 mm thin-film detectors, and characterized 2.4/2.92 mm adapters. The new service was developed in cooperation with the Air Force, Army, and Navy Primary Standards Laboratories.
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**NIST STUDY ACCELERATES UNDERSTANDING OF OXIDATION MECHANISMS IMPORTANT TO LASER MANUFACTURERS**

Researchers at NIST have shown that the oxidation kinetics of AlGaAs are independent of semiconductor growth method and edge preparation conditions. Native semiconductor oxide layers are critical components of optoelectronic devices, such as vertical-cavity surface-emitting lasers (VCSEL) used in high-speed data communication, in which they provide optical and electrical confinement. VCSEL manufacturers have reported difficulties with the repeatability of their oxidation process.

NIST researchers conducted a study of oxidation rate as a function of relevant semiconductor growth and processing variables for initial AlGaAs layers having Al mole fractions from 0.9 to 1.0. They found that, contrary to the expectations of some device manufacturers, the oxidation rate did not depend on whether the initial layers were grown by molecular beam epitaxy or metalorganic chemical vapor deposition (MOCVD), the two methods most commonly used by the industry. The oxidation was independent of the V/III ratio of the growth, impurity level in the initial epilayer, and specimen edge preparation, whether wet etched, ion milled, chemically-assisted ion-beam etched, or cleaved. As expected, the oxidation reaction kinetics were a sensitive function of semiconductor composition, oxidation temperature, and time. The study did reveal, in one sample set grown by MOCVD by an outside laboratory, unintentional fluctuations in the epilayer composition during growth (as confirmed by SIMS analysis), which increased the oxidation rate.

The results of the NIST study are providing VCSEL manufacturers valuable insight into the tolerances of their native oxide fabrication process. They are also important input to a broader investigation of the impact of strain on device reliability. More details can be found in the paper "Comparison of AlGaAs Oxidation in MBE and MOCVD Grown Samples," by Y. Chen et al., Mat. Res. Soc. Symp. Proc. (2002) p. H6.11.1.
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**NIST RESEARCHERS MEASURE WAVELENGTH-DEPENDENT GAIN OF RAMAN FIBER OPTICAL AMPLIFIERS**

Staff at NIST recently completed measurements of the dependence of Raman gain in optical fiber on both the difference between the pump and signal wavelengths and the absolute pump wavelength. These measurements, made on four standard telecommunication fibers, represent the first direct measurements of the pump-wavelength dependence. The pump-wavelength dependence was measured using two complimentary techniques; a brute-force comparison of the Raman gain at different pump wavelengths and a simpler, more elegant comparison of the asymmetry in the Stokes and anti-Stokes Raman gain at a fixed pump wavelength.

Fiber Raman amplifiers are becoming increasingly important in optical fiber communication systems since they provide both lower noise performance and a wider wavelength coverage than conventional optical amplifiers. In fiber Raman amplifiers, a strong pump laser provides gain to signals at longer wavelengths through stimulated Raman scattering within the optical transmission fiber. The Raman gain will depend strongly on the wavelength difference between the pump and signal beams and weakly on the absolute pump wavelength. Previous measurements of the Raman gain have focused on its strong dependence on the wavelength difference between the pump and signal beams and have ignored the weaker pump-wavelength dependence. With the growing potential for widespread use of fiber Raman amplifiers in deployed systems, more complete measurements of the Raman gain are needed to provide input for system simulations.
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**NIST DEVELOPS ACCURATE MODEL FOR ION BOMBARDMENT ENERGIES IN PLASMA ETCHERS**

NIST scientists have recently developed and validated a model for predicting the kinetic energy of ions in plasma etching reactors used by the semiconductor industry. During plasma etching, substrates are bombarded by reactive chemical species and energetic ions generated in the plasma, resulting in selective removal of material from exposed areas of the substrate. The energy of ions striking the substrate surface plays an important role in determining the etching rate and the profile of etched features. To control ion energies, radio-frequency (rf) power is applied to the substrate electrode, but the effect of the rf power on ion energies is quite complicated. Models describing the relation between rf power and ion energy have been developed, but they often involve simplifying assumptions that have never been rigorously tested. Consequently, it is difficult to predict and to optimize ion energy distributions.

At NIST, a plasma model has recently been developed to predict ion energy distributions. This model includes a complete treatment of the time-dependent ion kinetics in the plasma sheath, the thin region between the plasma and the substrate surface. Unlike previous models, no simplifying assumptions are made regarding the time scale of ion motion or the frequency of the rf power applied to the substrate.

The new model has recently been validated by a comprehensive set of experiments performed in an inductively coupled plasma reactor. Measurements of ion energy distribution made by a mass spectrometer were combined with capacitive probe measurements of the time-dependent plasma potential and Faraday cup measurements of the total ion flux. Together, these measurements completely determine all the input parameters of the model, allowing a direct comparison of model results and measurements. Ion energy distributions predicted by the model were in good agreement with measured distributions over the entire range of frequencies investigated. The model was found to accurately predict the dependence of ion energy distributions on rf frequency, rf amplitude, total ion flux, and ion mass. The validated model can be adapted for use in commercial plasma simulations. It also enables new, model-based methods for in situ monitoring of ion energies during plasma etching.
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