

layer to serve as a template for epitaxial growth. The third was a 3- μm -thick GaN epilayer containing electron-donor (n) doping at a density of $4.8 \times 10^{18} \text{ cm}^{-3}$. The fourth was a 0.75- μm -thick GaN epilayer n-doped at a density of $\approx 10^{16} \text{ cm}^{-3}$.

Four masks were used to define features of devices having Schottky contact areas ranging up to the aforementioned maximum of 1 cm square. Mesas (one for each device) were first defined by use of conventional photolithography and chlorine-bromine reactive-ion etching for complete removal of the n epilayer. Metal patterns, each consisting of a 10-nm-thick layer of Ti followed by a 10-nm-thick layer of Ni followed by a

150-nm-thick layer of Al, were defined at the bottoms of the mesas by means of a lift-off procedure and electron-beam evaporation. These metal patterns were annealed at a temperature of 500 °C for 10 minutes in flowing nitrogen to form ohmic contacts.

Next, semitransparent Pt Schottky contacts having a thickness of 10 nm were defined on the tops of the mesas by means of a lift-off procedure. Contact rings, each consisting of a 30-nm-thick layer of Pt followed by a 150-nm-thick layer of Au, were formed on the peripheries of the semitransparent Pt Schottky areas by electron-beam evaporation and lift-off.

In preliminary tests of the electrical characteristics of these devices, forward and reverse current-vs.-voltage characteristics were measured in a dark enclosure. The measurements confirmed that as desired, these devices are characterized by low levels of dark current at low reverse bias voltage: For example, one device having an active area of 0.25 cm² exhibited a leakage current density of only 14 pA/cm² at a reverse bias of 0.5 V (see figure).

This work was done by Shahid Aslam and David Franz of Raytheon Co. for Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-14777-1

Fiber Bragg Grating Sensor System for Monitoring Smart Composite Aerospace Structures

Dryden Flight Research Center, Edwards, California

Lightweight, electromagnetic interference (EMI) immune, fiber-optic, sensor-based structural health monitoring (SHM) will play an increasing role in aerospace structures ranging from aircraft wings to jet engine vanes. Fiber Bragg Grating (FBG) sensors for SHM include advanced signal processing, system and damage identification, and location and quantification algorithms. Potentially, the solution could be developed into an autonomous onboard system to inspect and perform non-destructive evaluation and SHM.

A novel method has been developed to massively multiplex FBG sensors, supported by a parallel processing interrogator, which enables high sampling rates combined with highly distributed sensing (up to 96 sensors per system). The interrogation system comprises several subsystems. A broadband

optical source subsystem (BOSS) and routing and interface module (RIM) send light from the interrogation system to a composite embedded FBG sensor matrix, which returns measurement-dependent wavelengths back to the interrogation system for measurement with subpicometer resolution. In particular, the returned wavelengths are channeled by the RIM to a photonic signal processing subsystem based on powerful optical chips, then passed through an optoelectronic interface to an analog post-detection electronics subsystem, digital post-detection electronics subsystem, and finally via a data interface to a computer.

A range of composite structures has been fabricated with FBGs embedded. Stress tensile, bending, and dynamic strain tests were performed. The experimental work proved that the FBG sen-

sors have a good level of accuracy in measuring the static response of the tested composite coupons (down to sub-microstrain levels), the capability to detect and monitor dynamic loads, and the ability to detect defects in composites by a variety of methods including monitoring the decay time under different dynamic loading conditions.

In addition to quasi-static and dynamic load monitoring, the system can capture acoustic emission events that can be a prelude to structural failure, as well as piezoactuator-induced ultrasonic Lamb-waves-based techniques as a basis for damage detection.

This work was done by Behzad Moslehi and Richard J. Black of Intelligent Fiber Optic Systems Corp. and Yasser Gowayed of Auburn University for Dryden Flight Research Center. Further information is contained in a TSP (see page 1). DRC-011-004

Health-Enabled Smart Sensor Fusion Technology

Stennis Space Center, Mississippi

A process was designed to fuse data from multiple sensors in order to make a more accurate estimation of the environment and overall health in an intelligent rocket test facility (IRTF), to provide reliable, high-confidence measurements for a variety of propulsion test articles.

The object of the technology is to provide sensor fusion based on a distributed

architecture. Specifically, the fusion technology is intended to succeed in providing health condition monitoring capability at the intelligent transceiver, such as RF signal strength, battery reading, computing resource monitoring, and sensor data reading. The technology also provides analytic and diagnostic intelligence at the intelligent trans-

ceiver, enhancing the IEEE 1451.x-based standard for sensor data management and distributions, as well as providing appropriate communications protocols to enable complex interactions to support timely and high-quality flow of information among the system elements.

Troubleshooting is simplified through sensor fusion that allows users to inter-