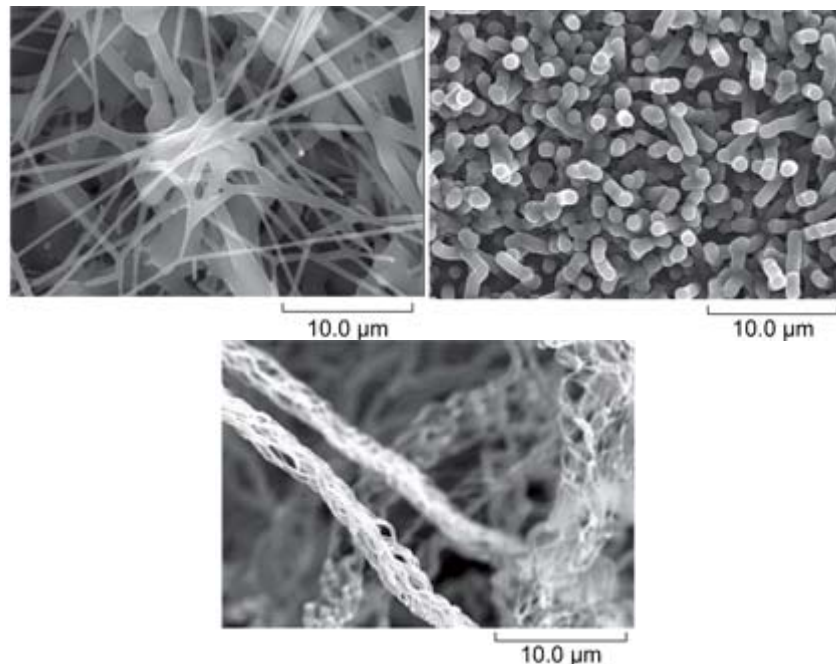


# Nanorod Material Developed for Use as an Optical Sensor Platform

Optical sensors are becoming increasingly important in the development of new nonintrusive or embedded sensors. The use of light and material optical properties helps us measure unknown parameters such as temperature, pressure, flow, or chemical species. The focus of this work is to develop new nanostructure platforms upon which optical sensors can be constructed. These nanorods are synthesized oxides that form a base structure to which luminescent sensing dyes or dopants can be attached or embedded. The nanorod structure allows for a much greater open area than closed or polymer-based sensors do, enabling a much faster contact of the measured species with the luminescent sensor and, thus, a potentially faster measurement.

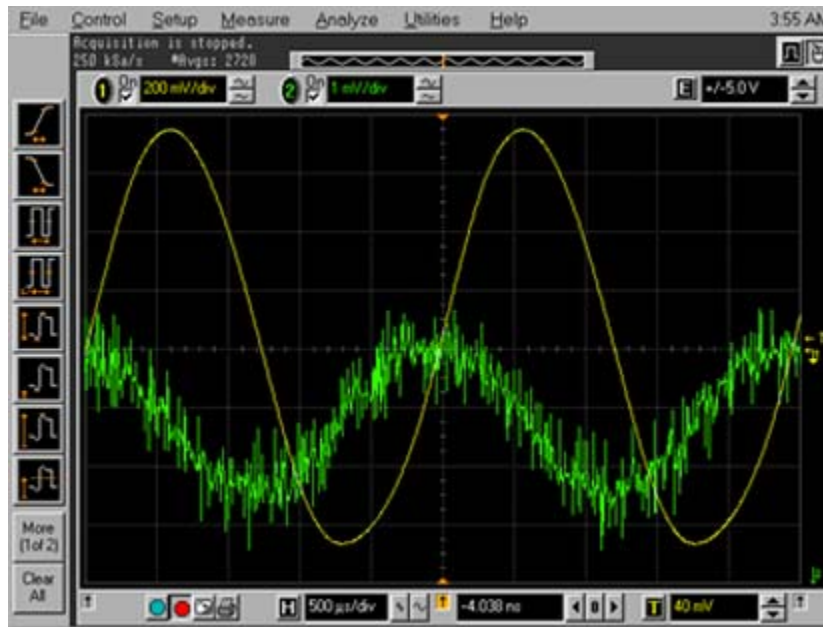
The initial development of the nanorod-based optical sensor has been as a fast-response air-pressure sensor. This concept offers the ultimate in sensor surface area: it maximizes sensor-to-media interaction because it is just above the molecular size scale. The pressure sensing works on the basis of oxygen quenching, or the available oxygen in air. Having a very open structure (approximately 100 times more open than similar sensors) on which the dye is attached allows an unimpeded movement of air molecules in and out of the pressure sensor, providing the very fast response. The idea is to have an entire surface area function as a pressure transducer rather than using a single embedded wired sensor. The surface would be probed with a laser to measure the pressure and temperature of the dye, thus providing an unlimited number of measurement locations.



*Left: Scanning electron microscope image of the tangled-mat optical platform. The weblike structure adds to the platform's overall physical properties. Center: Scanning*

*electron microscope image of the regularly oriented array concept for potential use as an optical sensor. This structure has a grasslike appearance with all individual limbs aligning; this type of platform has potential as an optical flow sensor. Right: Scanning electron microscope image of braided ropelike structures, which have more mechanical strength than the individual strands shown in the center photograph.*

The nanorod structures that have been produced can be classified in two categories, tangled mats and regularly oriented arrays, as illustrated in the microscopic images. Tangled mats are characterized by their random -orientation and cross-connecting, which provide higher strength, high porosity, and large surface area normal to the sensing direction. The regularly oriented arrays can grow in various geometries, often producing round or rectangular cross sections resembling nanoribbons or nanobelts, producing a more delicate, ordered arrangement. Samples of several different materials and shapes have been dyed using a dipping method with no adverse physical changes to the nanostructure. Optical characterization of the pressure sensor for pressure response, photostability, and frequency response is ongoing.



*Oscilloscope trace showing signals measured from a conventional wired pressure transducer and from the fast-response optical-pressure sensor.*

**Find out more about this research at <http://www.grc.nasa.gov/WWW/OptInstr/>**

**Glenn contacts:** Timothy J. Bencic, 216-433-5690, Timothy.J.Bencic@nasa.gov, and Dr. Randall L. Vander Wal, 216-433-9065, Randall.L.VanderWal@grc.nasa.gov

**Author:** Timothy J. Bencic

**Programs/Projects:** Glenn IR&D