



Improved Oxygen-Beam Texturing of Glucose-Monitoring Optics

Textures can be more nearly optimized for greater utilization of light.

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An improved method has been devised for using directed, hyperthermal beams of oxygen atoms and ions to impart desired textures to the tips of polymethylmethacrylate [PMMA] optical fibers to be used in monitoring the glucose content of blood. The improved method incorporates, but goes beyond, the method described in "Texturing Blood-Glucose-Monitoring Optics Using Oxygen Beams" (LEW-17642-1), *NASA Tech Briefs*, Vol. 29, No. 4 (April 2005), page 11a.

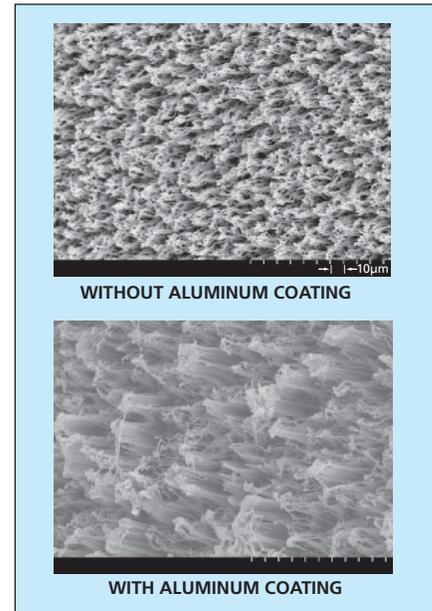
The basic principle of operation of such a glucose-monitoring sensor is as follows: The textured surface of the optical fiber is coated with chemicals that interact with glucose in such a manner as to change the reflectance of the surface. Light is sent down the optical fiber and is reflected from, the textured surface. The resulting change in reflectance of the light is measured as an indication of the concentration of glucose.

The required texture on the ends of the optical fibers is a landscape of microscopic cones or pillars having high aspect ratios (microscopic structures being taller than they are wide). The average distance between hills must be no more than about 5 μm so that blood cells (which are wider) cannot enter the valleys between the hills, where they would interfere with optical sensing of glucose in the blood plasma. On the other hand, the plasma is required to enter the valleys, and high aspect ratio structures are needed to maximize the surface area in contact with the plasma, thereby making it possible to obtain a given level of optical glucose-measurement sensitivity with a relatively small

volume of blood. There is an additional requirement that the hills be wide enough that a sufficient amount of light can propagate into them and, after reflection, can propagate out of them.

The method described in the cited prior article produces a texture comprising cones and pillars that conform to the average-distance and aspect-ratio requirements. However, a significant fraction of the cones and pillars are so narrow that not enough light can propagate along them. The improved method makes it possible to form wider cones and pillars while still satisfying the average-distance and aspect-ratio requirements.

In the improved method, as in the previously reported method, multiple optical fibers are first bundled together for simultaneous texturing of their distal tips. However, prior to texturing by exposure to an oxygen beam, the tips are first coated by vapor deposition of a thin, sparse layer of aluminum: The exposure to the aluminum vapor must be short enough (typically of the order of seconds) so that the aluminum nucleates into islands separated by uncoated areas. The coated tips are textured by exposure to a directed beam of hyperthermal (kinetic energy >1 eV) oxygen atoms and/or ions in a vacuum chamber, as in the previously reported method. The aluminum islands partially shield the underlying PMMA from oxidation and erosion by the beam, so that the cones or pillars remaining after texturing are wider than they would otherwise be. To some extent, the dimensions of the hills and the distances between them can be tailored through choice of the thickness of the alu-



These **Scanning Electron Micrographs** show the results of oxygen-beam texturing of the tips of two PMMA optical fibers: one that was not coated and one that was sparsely coated with aluminum.

minum coat and/or the oxygen-beam fluence. The figure illustrates an example of texturing of the tip of a PMMA optical fiber without and with prior aluminum coating.

This work was done by Bruce A. Banks of Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-17975-1.

Tool for Two Types of Friction Stir Welding

The same mechanism could be used for conventional or self-reacting FSW.

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A tool that would be useable in both conventional and self-reacting friction stir welding (FSW) has been proposed. The tool would embody both a prior

tooling concept for self-reacting FSW and an auto-adjustable pin-tool (APT) capability developed previously as an augmentation for conventional FSW.

Some definitions of terms are prerequisite to a meaningful description of the proposed tool. In conventional FSW, depicted in Figure 1, one uses a tool that

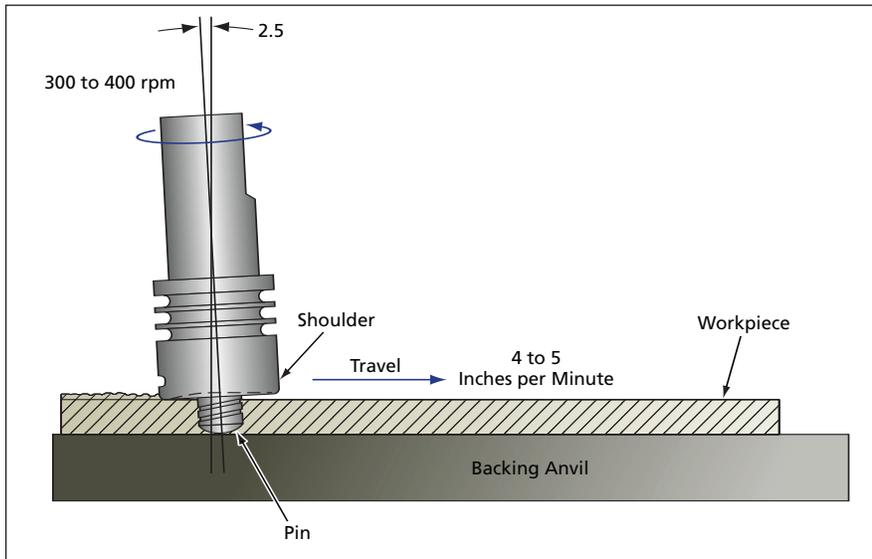


Figure 1. In **Conventional FSW**, the force exerted by the tool on the workpiece is reacted by the backing anvil.

includes (1) a rotating shoulder on top (or front) of the workpiece and (2) a rotating pin that protrudes from the shoulder into the depth of the workpiece. The main axial force exerted by the tool on the workpiece is reacted through a ridged backing anvil under (behind) the workpiece. When conventional FSW is augmented with an APT capability, the depth of penetration of the pin into the workpiece is varied in real time by a position- or force-control system that extends or retracts the pin as needed to obtain the desired effect.

In self-reacting (also known as self-reacted) friction stir welding (SR-FSW), there are two rotating shoulders: one on top (or front) and one on the bottom (or back) of the workpiece. In this case,

a threaded shaft protrudes from the tip of the pin to beyond the back surface of the workpiece. The back shoulder is held axially in place against tension by a nut on the threaded shaft. The main axial force exerted on the workpiece by the tool and front shoulder is reacted through the back shoulder and the threaded shaft, back into the FSW machine head, so that a backing anvil is no longer needed. A key transmits torque between the bottom shoulder and the threaded shaft, so that the bottom shoulder rotates with the shaft. A tool for SR-FSW embodying this concept was reported in "Mechanism for Self-Reacted Friction Stir Welding" (MFS-31914), *NASA Tech Briefs*, Vol. 28, No. 10 (October 2004), page 53.

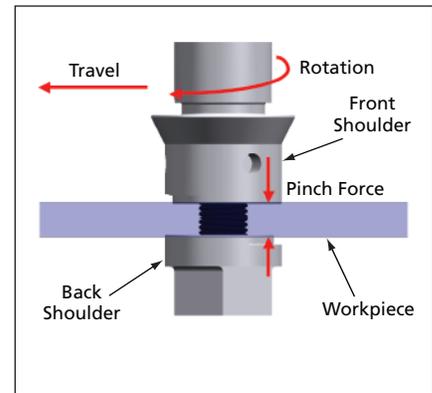


Figure 2. The **Proposed Tool** would include a pin modified to accept a back shoulder.

In its outward appearance, the proposed tool (see Figure 2) would fit the above description of an SR-FSW tool. In this case, the FSW machine would have an APT capability and the pin would be modified to accept a bottom shoulder. The APT capability could be used to vary the distance between the front and back shoulders in real time to accommodate process and workpiece-thickness variations. The tool could readily be converted to a conventional FSW tool, with or without APT capability, by simply replacing the modified pin with a conventional FSW pin.

This work was done by Robert Carter of Marshall Space Flight Center. Further information is contained in a TSP (see page 1).

This invention has been patented by NASA (U.S. Patent No. 6,758,382). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to Sammy Nabors, MSFC Commercialization Assistance Lead, at sammy.a.nabors@nasa.gov. Refer to MFS-31647-1.