Texturing Blood-Glucose-Monitoring Optics Using Oxygen Beams

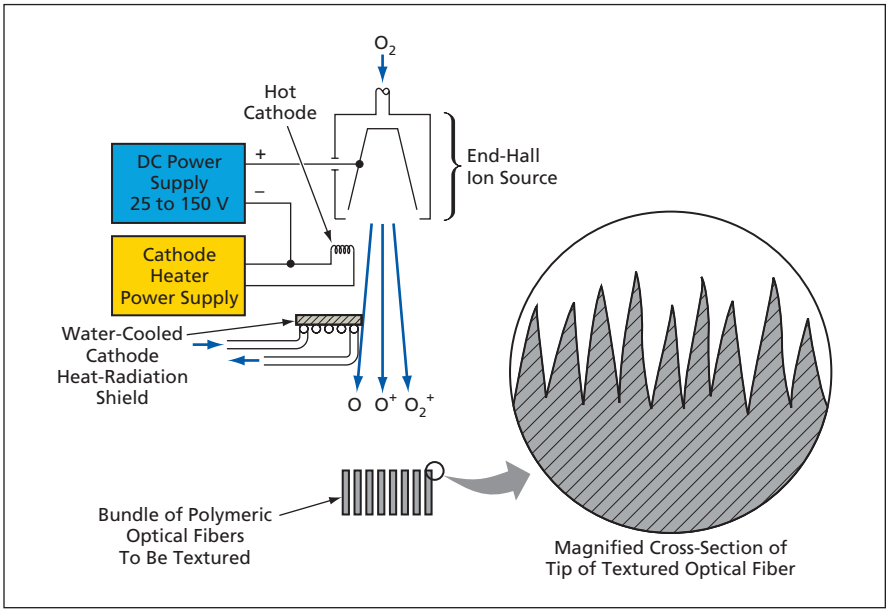
Textures can be tailored to exclude blood cells from optical-sensing regions.

John H. Glenn Research Center, Cleveland, Ohio

A method has been invented for utilizing directed, hyperthermal oxygen atoms and ions for texturing tips of polymeric optical fibers or other polymeric optical components for use in optical measurement of concentration of glucose in blood. The required texture of the sensory surface of such a component amounts to a landscape of microscopic hills having high aspect ratios (hills taller than they are wide), with an average distance between hills of no more than about 5 μm. This limit on the average distance between hills is chosen so that blood cells (which are wider) cannot enter the valleys between the hills, where they could obstruct optical sensing of glucose in the blood plasma. On the other hand, the plasma is required to enter the valleys, and a high aspect ratio is intended to maximize the hillside and valley 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.

The present method of texturing by use of directed, hyperthermal (particle energy >1 eV) oxygen atoms and ions stands in contrast to a prior method of texturing by use of thermal monatomic oxygen characterized by a temperature of the order of 0.5 eV. The prior method yields low-aspect-ratio (approximately hemispherical) craters that are tens of microns wide — too wide to exclude blood cells.

The figure schematically depicts parts of a typical apparatus for texturing according to the present method. One or more polymeric optical components to be textured (e.g., multiple optical fibers bundled together for simultaneous processing) are mounted in a vacuum chamber facing a suitable ion- or atom-accelerating device capable of generating a beam of oxygen atoms and/or ions having kinetic energies >1 eV. Typically, such a device includes a heated cathode, in which case it is desirable to interpose a water-cooled thermal-radiation shield to prevent melting of the polymeric component(s) to be textured. In operation, the chamber is evacuated to a pressure $\leq 10^{-5}$ torr (less than or equal to approximately 1.3 mPa), then the beam is turned on.



Directed Energetic Oxygen Atoms and Ions impinging on tips of polymeric optical fibers cause the tips to become textured with microscopic, approximately conical hills having large aspect ratios.

The resulting texture is characterized by approximately conical hills having aspect ratios greater than 1. In experiments, it was demonstrated that separations between adjacent hills can be made ≤1 μm and that the separations and heights of the hills can be varied by varying the fluence of monatomic oxygen and/or oxygen ions.

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

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