NASA's Bionic Eyes

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The human eye contains millions of rods and cones within the retina in the back of the eye. The rods and cones are responsible for converting the light absorbed by the eye into electrical impulses that can be picked up by the optic nerve and carried to the brain where images are formed. For many, especially the elderly, vision problems occur when these rods and cones malfunction.

The Space Vacuum Epitaxy Center (SVEC), a NASA Commercial Space Center at the University of Houston, has developed an optical detector in hopes of correcting this kind of malfunction in the eye. For cases where rods and cones may be damaged, but connections with the optic nerve are still intact, the detector is implanted into the retina to replace the sensors.

Epitaxy is the technique the SVEC scientists use to grow the oxide (ceramic) films that make up the detectors, atom-by-atom and layer-by-layer. The films are formed in arrays, which are stacked in a hexagonal structure similar to natural rods and cones. This arrangement also allows for nutrients to flow from the back to the front of the eye without any disruption. One film contains 100,000 tiny detectors based on $PbLaZrTiO_3$ (PLZT) and $BiVMnO_3$ (BVMO) which were found to exhibit a strong photo response in the visible range of 380 nm to 650 nm.

In order for the surgeon to safely handle the film, it is attached to a polymer one millimeter by one millimeter in size. An incision is made in the white portion of the eye and the retina is elevated by injecting fluid underneath. A blister is formed and the optical detector is placed inside. A couple of weeks later the polymer dissolves and the array is left intact.

The optical detector converts light into electrical signals in much the same way as rods and cones. Signals stimulate the retinal ganglia and the impulses are then picked up by the optic nerve. It is not yet certain how the brain will interpret unfamiliar voltages, but scientists believe the brain will eventually adapt probably through a slow learning process similar to the way an infant learns shapes and colors for the first time.

Preliminary testing has been successful so far. These ceramic films have been implanted in the eyes of rabbits for biocompatibility testing and SVEC scientists are now testing optical capabilities.

For more information go to:
http://www.svec.uh.edu/BIONIC.html
http://science.nasa.gov/headlines/y2002/03jan_bioniceyes.htm