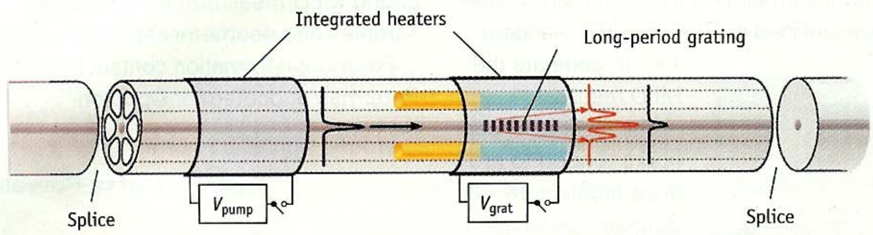
Microfluidic fiber for tunable transmission

Fibers may take a more active role in future communications systems if a new class of devices proves successful. A recent collaboration by Lucent Technologies and OFS Laboratories (both in Murray Hill, NJ) has produced a tunable-fiber notch filter that requires only the addition of the appropriate control voltages to make it work; no other external components are required. Tuning is achieved by changing the position and refractive index of a liquid that is trapped inside the fiber in microfluidic channels. Both wavelength and notch depth can be controlled independently.



Integrated heaters manipulate the position (pump) and temperature (grating) of two plugs of liquid within microchannels around the fiber core. The position of the high/low refractive-index boundary determines the depth of the notch filter (increasing from left to right). Changing the temperature across the grating from 25°C to 16°C changes filtered wavelength from 1545 to 1555 nm.

The tunable-fiber notch filter requires only the addition of control voltages to work.

The new devices are based on a microstructured fiber that is channeled by a layer of air between the core and the outer cladding.[1] The Lucent/OFS team recognized that they could introduce liquids into these capillaries and then manipulate their properties using resistive microheaters. In particular, they determined that the liquid would not need to be present or controlled throughout the fiber, but only at certain critical positions.

In the tunable notch filters, a long-period grating provides the focus for the liquid interaction (see figure). The operation of this grating is strongly affected by the refractive index of the fiber around it. When the integrated heaters are turned off, two "plugs" (small amounts) of high- and low-refractive-index liquid are positioned so the fiber allows normal core transmission: this occurs when the grating is entirely surrounded by a low-index medium and total internal reflection confines the light.

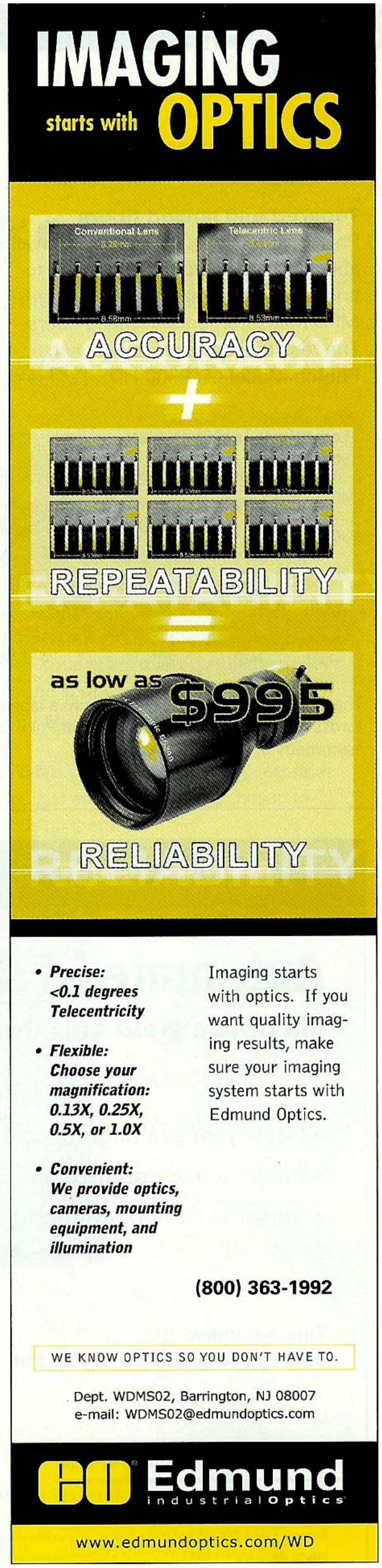
When the pump heater is turned on (so called because it heats up the air locally, pushing or pumping the air forward), the high-index plug comes into play, forcing the fiber to operate in cladding mode. When this happens, a narrow-band loss occurs, turning the fiber into a notch filter. The depth of the notch is determined by the length of grating surrounded by the high-index liquid.

The frequency of the notch is controlled by the relative refractive index between the cladding and the core at the grating, and thus of the plug liquids. A second heater changes the temperature of the liquids at this position, thereby changing their refractive index and the transmission characteristics of the device. For information contact John Rogers at jarogers@lucent.com.

Sunny Bains

REFERENCE

1. P. Mach et al., *Appl. Phys. Lett.* *80(23)*, 4294 (June 10, 2002).



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