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Hollow promise for fibre optics

Optical fibre can process light as well as transmit it.
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PHILIP BALL

Fibre optics could have a colourful future in communications.
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Optical fibres currently do the boring legwork in telecommunications. Soon these light-filled strands may play a more active role. Researchers at Bell Laboratories in Murray Hill, New Jersey, have created optical fibres that can be switched between different states that transmit light of different colours[1]. These fibres can process signals as well as carry them.

Devised by John Rogers and his colleagues, the new fibres are hollow. Perforated with channels thousandths of a millimetre across, each fibre looks like a bundle of drinking straws. Their tunable behaviour comes from plugs of fluid within that can be pumped back and forth.

These 'microfluidic fibres' combine the cheapness and robustness of conventional fibre optics with the functionality of more complex and expensive devices. Currently, when switches or transistors are installed midway along the length of a fibre, they can end up buried and inaccessible along underground or seafloor transmission lines. Breakdowns in such cases are understandably costly.

Wavelength-division multiplexing, for instance, is a common way of sending many optical signals down a single fibre simultaneously. Different signals, encoded in light beams of different colours, are unravelled at the receiving end using special filters or light sensors.

Microfluidic fibres could act as both transmission channel and filter, and could be switched to relay first one signal and then another - without all the separate paraphernalia that is otherwise needed to decode the signals.

The fluid plugs alter the fibres' light-conducting behaviour. Light travelling through the fibres' solid glass core changes when it passes through a region surrounded by fluid. Under certain conditions, this can make the fibre relatively opaque to light of a narrow band of wavelengths, so that the fibre filters it out.

The filtered wavelength can be tuned by altering the temperature of the fluid; this is done by a tiny electrical 'heater' wrapped like a sleeve around a short section of the fibre. The wavelength and attenuation of the filtering can be controlled using a second heater further down the fibre, to warm up the air in the channels. This pumps the liquid plugs further inside or outside the region where they become active as filters.

Rogers and colleagues anticipate that other arrangements of fluid plugs, heaters, pumps and so on will fulfil a variety of other functions that are needed in optical-fibre communication networks.

References

1. Mach, P. et al. Tunable microfluidic optical fiber. ***Applied Physics Letters***, **80,** 4294 - 4296, (2002).

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