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SPECIAL ISSUE: REVIEW OF THE YEAR

All the best R&D, technology transfer and innovation in European optical communications

Polymer multiplexers eye access networks

When it comes to optical integration, polymer devices combine a number of compelling features, not least a wide refractive-index tuning range, superior thermal functionality, low power consumption and a production process that is highly conducive to volume ramp-up. Now, a German collaboration is looking to capitalize on all of these advantages with a range of integrated optical components. One of the highlights so far is a four-channel reconfigurable optical add–drop multiplexer (ROADM).

The researchers, from Berlin's Heinrich Hertz Institute (HHI) and Fraunhofer Institute for Reliability and Microintegration, fabricated the ROADM from a fluoroacrylate polymer with a refractive index contrast of 0.011 and a propagation loss of 0.8 dB/cm at 1550 nm. The device comprises two arrayed-waveguide gratings (AWGs) and an array of four 2 × 2 digital thermo-optic switches.

While traditional interferometer-based switches boast low-switching-power requirements, their performance is sensitive to temperature, polarization and wavelength. By comparison, polymer-based devices exhibit robust switching behaviour on all counts.

Input and add signals entering the ROADM are demultiplexed by the first AWG and then fed into the array of 2 × 2 switches. The signals travel on into the second AWG, which acts as a multiplexer. By controlling the switch states the researchers can route the input and add signals to either the device's output or drop port.

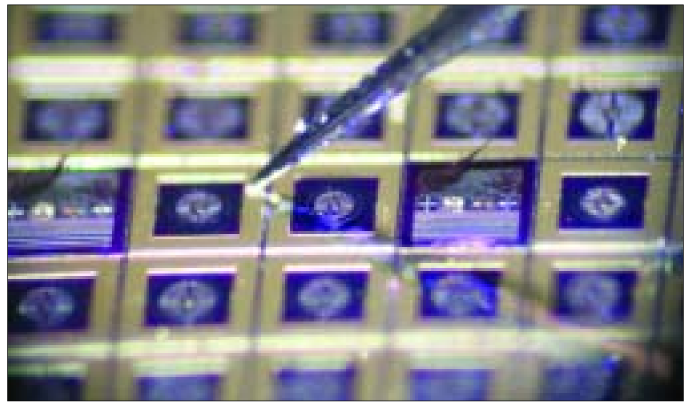
HHI has also created an integrated passive OADM chip that is just 15 × 2 mm in size. "You can fabricate more than 100 of these chips on a 4 inch wafer," explained HHI researcher Norbert Keil, before concluding: "This is quite attractive, particularly with regard to FTTH networks. We believe that access will be a new playground for our polymer technology."

The 1200 GHz device demonstrates a crosstalk of around –30 dB and an insertion loss of 3 dB. The researchers say that the insertion loss can be reduced by using lower-loss polymers and/or more compact designs. Another key target is to develop polymers with improved long-term reliability.

MEMS enhance SOA tuning range

Pioneers of vertical-cavity semiconductor optical amplifiers (VCSOAs) tout these next-generation devices as a low-cost alternative to erbium-doped fibre amplifiers and in-plane SOAs for metro and access networks. They cite benefits such as low power consumption, high fibre-coupling efficiency, polarization-insensitive gain and compatibility with on-wafer testing.

Researchers at the University of California, Santa Barbara, US, have taken things further by incorporating a microelectromechanical systems (MEMS) element to create a VCSOA with an 11 nm tuning range. The research team formed the tunable VCSOA using an indium phosphide-based active region sandwiched between two aluminium-gallium-arsenide distributed Bragg reflectors. Applying a voltage to an overlying MEMS membrane tunes the amplification wavelength. The device exhibits more than 10 dB gain between 1580 and 1569 nm and has a peak gain of 17 dB at 1570 nm.



Stacked up: the researchers also fabricated two-dimensional arrays of VCSOAs.

Previous attempts at tuning VCSOAs via temperature control were hampered by a slow response (of the order of milliseconds) and a tuning range of just a few nanometres. MEMS-based electrostatic tuning, on the other hand, enables tuning speeds of a few microseconds and a wavelength range of tens of nanometres. In addition, electrostatic tuning consumes little power due to low current requirements, and does not need external components.

'SuperWDM' takes fibre transmission into the ultralong-haul

Raman amplification, optical solitons and all-optical regeneration are some of the technology options capable of supporting ultralong-haul (4000 km without electrical conversion) transmission in current and next-generation fibre networks.

But now, Huawei Technologies of China claims to have come up with its own "simpler, more flexible and lower-cost alternative" to ultralong-haul transport. Called SuperWDM, the technology uses a proprietary return-to-zero (RZ) coding scheme called SuperCRZ to modulate optical signals in both the frequency and time domains. This improves the transmission system's tolerance to the optical signal-to-noise ratio by suppressing nonlinear effects in the fibre.

"The RZ format has a low duty ratio and large pulse spacing, which reduces the inter-symbol interference," explained Soeren Puerschel of Huawei Technologies Deutschland. "It is strongly resistant to pulse distortion incurred by various nonlinear effects or polarization-mode dispersion, and the short pulse period also reduces multi-channel interference."

Noise reduction: SuperWDM enables 4000 km non-regenerated transmission.

The proprietary SuperCRZ coding adds a phase modulation (frequency chirp) to the inside bit period of each transmitted "1". This frequency chirp is in opposition to, and thus counteracts, chirp generated by self-phase modulation (SPM), dramatically reducing SPM degradation during transmission.

Another key feature is that SuperWDM uses 30–50 GHz of the 100 GHz-spaced ITU grid to carry a 10 Gbit/s signal (10 Gbit/s signals generally use about 20 GHz). This reduces the spectral power density and enables a higher per-channel launch power to be used without increasing nonlinear distortion.

Optical amplifier exploits quantum dots to ramp up the bandwidth

Optical amplifiers based on quantum dots (QDs) offer broadband gain and a high saturation output power. Such properties could make them ideal for use in low-cost CWDM systems that cover several transmission bands with a minimal number of amplifiers.

A Japanese collaboration (from the University of Tokyo, the Optoelectronic Industry and Technology Development Association, and Fujitsu) has developed a QD-based semiconductor optical amplifier (QD SOA) that is said to offer a wider bandwidth than that achieved by bulk or quantum-well SOAs, or any other existing optical amplifier.

The researchers fabricated the QD SOA using InAs QDs in InGaAsP on an InP substrate. The device achieved a gain of more than 25 (20) dB, a noise figure of less than 5 (7) dB, and a 3 dB saturation output power of more than 19 dBm, between approximately 1410 and 1500 (1530) nm.