Liquid Crystal WDM filter in Si photonic crystal technology with individual channel fine-tuning capability

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We demonstrate a simple, low-cost solution for a single multi-channel WDM (Wavelength Division Multiplexing) filter with fine–tuning capability of individual channels. The filter is based on Si photonic crystal technology and can be integrated with CMOS processes.

Although, fabrication technologies of Si integrated WDM systems have significantly advanced over the last decade, the most difficult challenges are posed by wavelength accuracy control as well as wavelength drifts and optical switching time. The proposed novel design of a multichannel integrated filter is based on the 1D silicon photonic crystal (PhC) model. By infiltration of the certain grooves of 1D PhC with matching filler, an efficient coupled Fabry-Pérot microresonator can be realized in which the wide-band stop band (SB) is used for frequency channel separation. By using the commercial nematic liquid crystal 5CB [1], we demonstrated electro-optical switching in the range of 30-50 nanoseconds and the continuous tuning of the individual channels up to 30 % of the channel-spacing. The fabricated multichannel filters have bandwidth of 0.1-0.9 nm with high extinction ration of 20dB at high modulation of reflection/ transmission coefficient. Using the gap map approach as a core engineering tool allows to predict formation and separation of transmission channels within the SBs and, thus, effectively determine the exact design parameters of the optical device. The obtained experimental spectral characteristics in the NIR range around 1.31 and 1.55 μm validated the proposed method and its applicability for the wavelength selective switching (WSS) as well as for the WDM in Si chip optical interconnects.

[1] M. W. Geis, T. M. Lyszczarz, R. M. Osgood, and B. R. Kimball, " 30 to 50 ns liquid-crystal optical switches", Opt. Express 18, 18886-18893 (2010)

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