Wavelength selective coupler based on Bragg Reflection Waveguide

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Highly wavelength selective optical filters are essential components for channel management in modern Dense Wavelength Division Multiplexed communication systems with 50GHz channel spacing and below 0.4nm channel bandwidth. We have designed, fabricated and characterized a new type of wavelength selective directional coupler, based on the high differential dispersion between a Bragg Reflection Waveguide (BRW) and a conventional buried channel silica waveguide. The bandwidth of the device is inversely proportional to the length of the coupler as well as to the differential effective refractive index dispersion of the coupled modal fields, at the wavelength of phase matching. The BRW is made of a high index (amorphous) silicon core layer, surrounded vertically by two periodic Bragg reflectors with alternating layers of silica and silicon. The silica waveguide with a Ge-doped core, vertically stacked with the BRW, allows fiber incoupling loss below 1dB which is essentially the insertion loss of the device. The device is operating within the optical bandgap of the Bragg reflectors. Both the bandwidth and the coupling wavelength can be tuned during the fabrication process: the fields' overlap and the coupling coefficient between the two waveguide modes are controlled by one of the Bragg reflectors (coarse control) and a spacer layer (fine control); the position of the coupling wavelength is mainly determined by the BRW core thickness.
The devices were fabricated by depositing SiO_2 and a-Si:H films on a 4" <100> oriented Si substrate, by plasma enhanced chemical vapor deposition, at a temperature of 250ºC. The 5µm wide vertical stack of BRW and silica waveguide were defined by lithography and etched in an inductively coupled plasma reactor. The 8.8µm thick coupler structure was covered with a 16µm thick silica cladding. The device can be easily integrated in a standard silica-based planar lightwave circuit. The measured filter suppression is 14dB and the FWHM is 0.29nm for only a 1.73mm long device, which is close to the estimated value of 0.31nm, and one of the lowest ever reported for this type of coupler.