**Wavelength demultiplexers based on coupled waveguide arrays with nonuniform lengths**

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We propose a demultiplexer based on linearly coupled waveguide array, implemented through a simple photonic lattice layout. Straight waveguides minimize propagation losses then bent waveguides, while choosing appropriate distances between waveguides enables us to tune the output wavelength and bandwidth.

For two input wavelengths, spatial divide is achieved when a shorter wavelength perfectly transfers it’s power from first to last, then back to the first waveguide, while longer wavelength’s power perfectly transfers from the first to last waveguide for the same length of waveguide array. Any waveguide array which supports periodic propagation and perfect transfer of light supports such multiplexing [1]. However, by selecting Clebsch–Gordan coupling coefficients, bandwidth can be controlled simply by changing the number of waveguides in an array, with the full-width at half-maximum narrowing with the square root of the waveguide number. An experimental proof of this concept was provided by fabricating the demultiplexers in borosilicate glass using femtosecond laser writing [2, 3].

Building upon these designs, we propose a more elaborate structure that introduces non-uniform waveguide lengths to enhance spectral separation for multiple wavelengths. In this configuration, only the input waveguide and its nearest neighbour retain equal lengths, while each subsequent waveguide is progressively shorter. We show results for a 3-wavelength demultiplexer with the maximum insertion loss of $1.22dB$ and the minimum cross talk of $-22.02dB$. For a 4-wavelength demultiplexer the maximum insertion loss is $2.76dB$ and the minimum cross talk is $-17.43dB$.

REFERENCES

[1] J. Petrović, J.Kršić, A. Maluckov, J.J.P Veerman “High-density optical interconnects based on self-imaging in coupled waveguide arrays”, J. Opt. Las. Technol. 163, 109381 (2023)

[2] M. G. Stojanović, P. Vildoso, K. Bugarski, P. M. Parra, A. Maluckov, R. A. Vicencio, and J. Petrović, "Wavelength demultiplexers based on finite photonic lattices" J. Opt. 27, 055801 (2025).

[3] D. Guzmán-Silva, G. Cáceres-Aravena, and R. A. Vicencio, "Experimental Observation of Interorbital Coupling" Phys. Rev. Lett. 127, 066601 (2021).