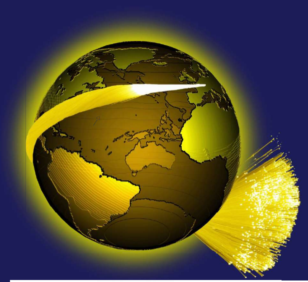

# Design and simulation of polymer based photonic components


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FHV RESEARCH

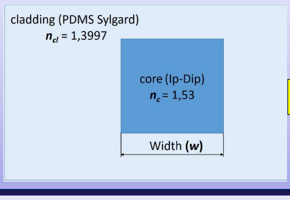
## Motivation

Introducing 3D sub-micrometer technologies based on polymers opened new possibilities of design and fabrication of photonic devices and components in 3D arrangement. 3D laser lithography is direct writing process based on two-photon polymerization exhibiting high accuracy and versatility, where numerous resists and even polymer ceramic mixtures can be used.

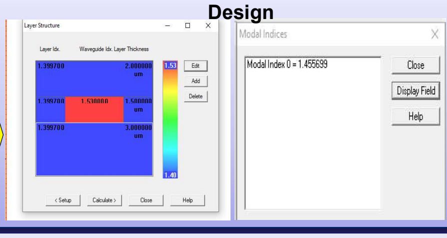
We present design and simulation of polymer-based photonic components with a focus on arrayed waveguide gratings (AWG) based on optical multiplexers/ demultiplexers and optical splitters. All optical components were designed for 1550 nm operating wavelength, applying two commercial photonics tools. **This study creates a basis for the design of optical components in 3D arrangement, which will be fabricated by 3D laser lithography.**

## Design of polymer waveguide structure

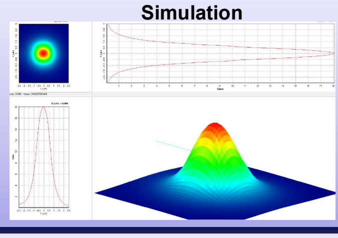
To design polymer waveguide structure, two different photonic tools were used: PHASAR from Optiwave Systems Inc. and APSS from Apollo Photonics Inc. To suppress polarization and wavelength dependent losses, the shape of the structure was chosen to be quadratic.




Design




Simulation



## Design of 16-channel, 100-GHz AWG

*Technological parameters taken to design AWG waveguide structure:*

- waveguide core size: 1.5 µm x 1.5 µm
- refractive index of the core, $n_c$ = 1.53
- refractive index of the cladding, $n_{cl}$ = 1.3997

*AWG type parameters:*

- number of output waveguides (channels) $N$ = 16
- AWG center wavelength $\lambda_c$ = 1.55 µm
- channel spacing: $df$ = 100 GHz

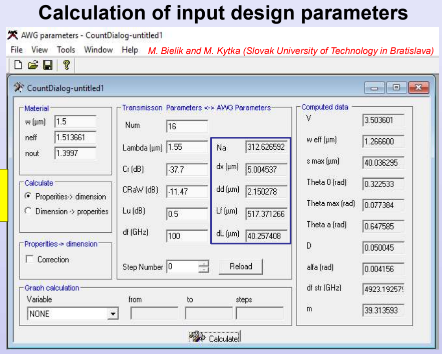
*Transmission parameters:*

- adjacent channel crosstalk between output waveguides (channels): $Cr$ = -37.7 dB
- adjacent channel crosstalk between arrayed waveguides: $CRaW$ = -11.47 dB
- uniformity over all the output channels (also called non-uniformity): $Lu$ = 0.5 dB

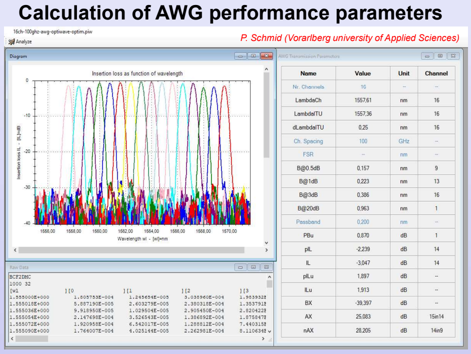
*Geometrical parameters:*

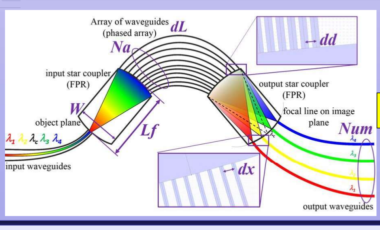
- number of arrayed waveguides: $Na$ = 312
- minimum waveguide separation between I/O waveguides: $dx$ = 5 µm
- minimum waveguide separation between PA array waveguides $dd$ = 2.15 µm
- coupler length: $Lf$ = 517.37 µm
- arrayed waveguide length increment: $dL$ = 40.2574 µm

Calculation of input design parameters

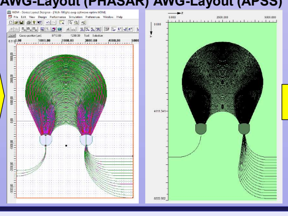



Calculation of AWG performance parameters

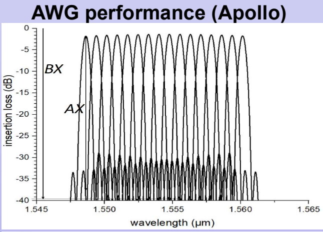


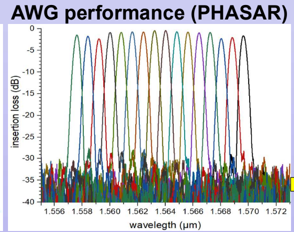

AWG-Layout (PHASAR) AWG-Layout (APSS)

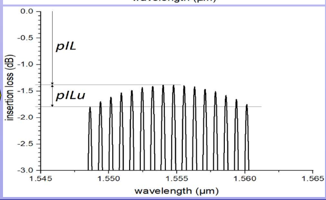


AWG performance (Apollo)




AWG performance (PHASAR)



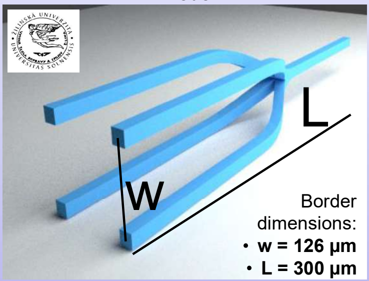




| 16-ch, 100-GHz AWG | Apollo | PHASAR |
|---|---|---|
| insertion loss, *pIL* | -1.38 dB | -2.239 dB |
| *IL* uniformity, *pILu* | 0.4 dB | 1.897 dB |
| adjacent ch. crosstalk, *AX* | 36.62 dB | 25.083 dB |
| non-adj. ch. crosstalk, *nAX* | 37.5 dB | 28.2 dB |
| background ch. crosstalk, *BX* | -39 dB | -39.397 dB |

## Design of 1x4 Y-branch splitter

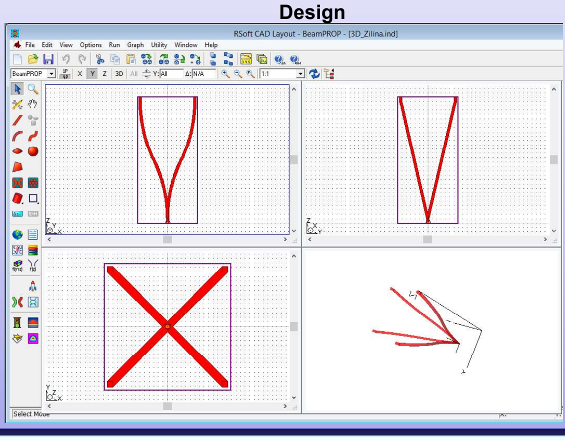
**Project goal:** Development of complete process of novel photonic devices based on polymers using 3D laser lithography system.

Model

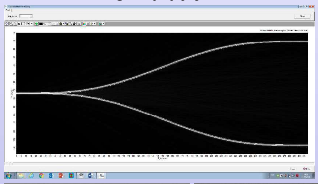


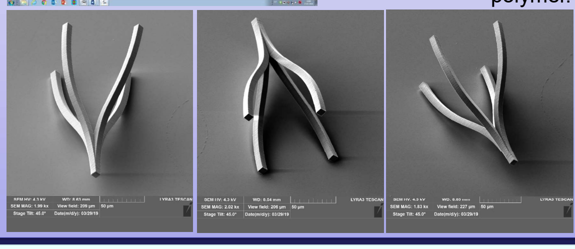

Border dimensions:
- w = 126 µm
- L = 300 µm

Design




Simulation





Scanning electron microscope images of 1x4 Y-branch splitters prepared from IP-Dip polymer.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