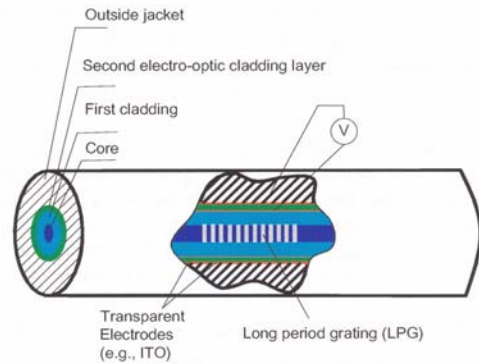


Objective

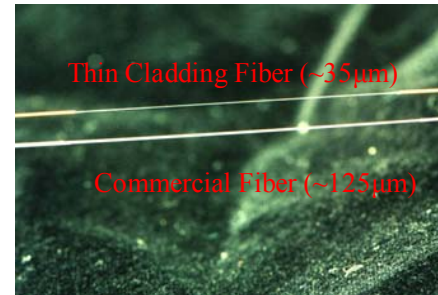
> To produce a thermally stable tunable filter that exceeds the performance capabilities of all commercially available tunable devices



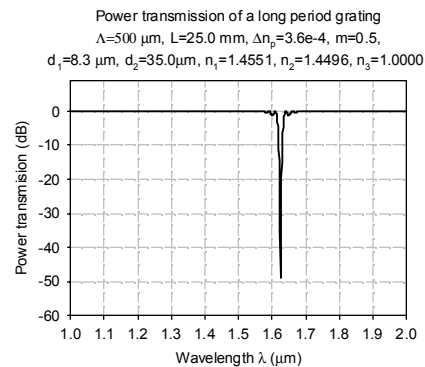
Tunable Filter Design Utilizing Long Period Grating, Ultra-Thin Cladding, and Electro-Optic Second Cladding Layer

Ultra-Thin Cladding

> Made by etching the cladding of a commercially available fiber with hydrofluoric acid (HF)



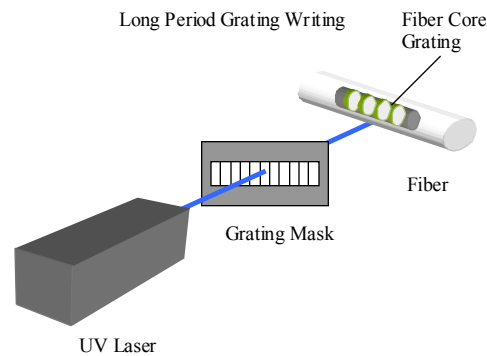
> Changes the spectral response of the long period grating to a single resonant peak



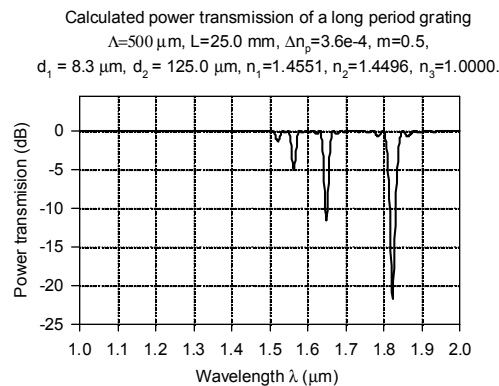
The resonant wavelength is filtered from the signal and is tuned by controlling the refractive index of the surrounding medium

Long Period Grating

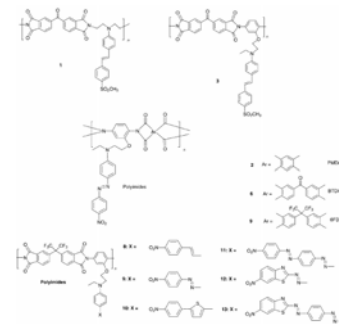
> Consists of periodic differences in the refractive index
 > Written to the core of a fiber using Ultra-Violet laser light and a mask



> Generates many resonant peaks in the spectral response by selectively coupling wavelengths from the core to the cladding



Electro-Optic Polymer



> Used as a second cladding to control the refractive index surrounding the ultra-thin cladding
 > Refractive index controlled by applied electric field

Projected Performance Characteristics

Low Insertion Loss
 <0.5 dB
3dB Bandwidth
 ~0.1 nm – 20 nm

Tuning Range
 > 50 nm
Tuning Speed
 ~ns

Major Advantages

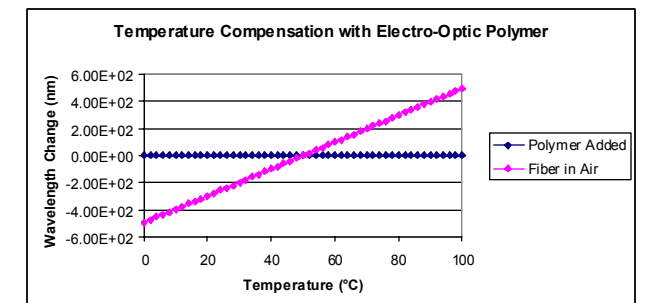
- > **Low insertion loss and easy to use**
 - * Constructed on an all fiber structure so no transmission medium is required
- > **Fast tuning speed**
 - * Since filter tuning is based on electro-optic effect, nanosecond tuning speed can be achieved
- > **Wide tuning range**
 - * Long period gratings are sensitive to refractive index change of the cladding, so a tuning range of greater than 50 nm (entire Erbium doped fiber amplifier (EDFA) spectral range) can be achieved by changing the refractive index of the unique electro-optic polymer layer
- > **Cost effective**
- > **Narrow bandwidth**
 - * Less than 0.5 nm with low side-lobes (<30 dB) due to the unique ultra thin silica cladding layer
- > **Single resonant band**
 - * Over the entire near infrared range (1000 nm – 1700 nm)

Thermal Effects

- > Filtered wavelength is a function of temperature without proper compensation
- > Thermal stability is achieved by adjusting the diameters of the two cladding layers and the design parameters of the electro-optic polymer
- > When the proper polymer is chosen, the thermal optic coefficient of the polymer compensates for the thermal properties of the silica core and first cladding
- > Without temperature dependence, wavelength is a function of applied electric field

Therefore, the filtered wavelength can be selected by changing the electric field applied to the polymer, and the tuning performance is constant over a range of temperatures.

> The plot below illustrates the effect of a polymer second cladding on a long period grating with ultra-thin cladding



Acknowledgements: We acknowledge the support of this work by US NAVAIR and Penn State/Lehigh COT: AON Thrust