Peridocally Poled Nonlinear Waveguide Materials
(PP-MgO:LN, PP-MgO:SLT, PP-MgO:SLN, PPLN)

HCP provides custom designed PPXX chips and professional services concerning any particular process. We also welcome joint R&D for promising projects. **HCP** keeps moving forward to produce the highest quality and the most stable frequency converters to right meet customers' need.

Technology (PPLN Waveguide, PP-MgO:LN Waveguide)

Periodically poled waveguides can further enhance nonlinear mixing efficiency as compare to bulk media, by tightly confining optical field over long distances. The tightly focused wave will often diffract when it propagates in a bulk device, so high conversion efficiency cannot be achieved.
In waveguides, the mode profile is confined to a transverse dimension on the order of the wavelength, then high optical intensities can be maintained over considerable distance to improve the conversion efficiency by two to three orders of magnitude as compare to bulk devices. Also, the nonlinear mixing efficiency is quadratic ally proportional to the interaction length of the waveguide device, thus the fabrication of long, uniform and low loss waveguide is essential for high efficiency optical frequency mixer.

All-Optical Signal Processing

HC Photonics introduces the first commercially available PPLN (Periodically Poled Lithium Niobate) waveguide in the market. PPLN waveguide can be used for the development of optical frequency (OF) mixers in which is well suited for optical fiber communication and other all-optical signal processing applications. Such optical frequency mixer is considered as enabling technology to realize high capacity and transparency in WDM and in high-speed TDM systems. Several potential OF mixer devices in which based upon the quasi-phase-matching (QPM) structure of PPLN waveguide have been practically and successfully demonstrated, including efficient WDM wavelength converters within the 1.5 µm band or between the 1.3-µm-band and the 1.5-µm-band, spectral inverters for dispersion compensation in fiber link and multiple-channel wavelength converters for dynamic reconfiguration and broadcasting. Also, the waveguides can be applied as all-optical gated mixers for managing high speed data in time-division multiplexed (TDM) system. By engineering such non-uniform QPM structures, the OF mixers can be further designed for devices with various novel functions.

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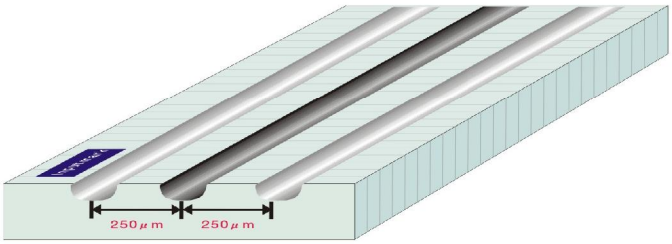
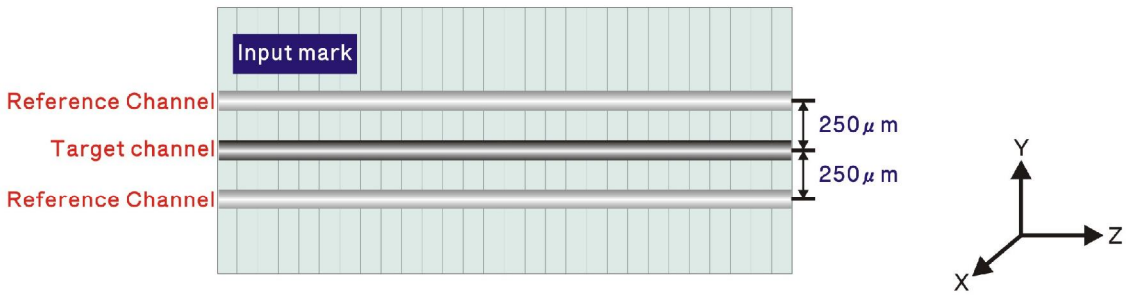
UV to Mid-IR Light Source Generation

PPLN waveguide also provides as a highly efficient guided device for the wavelength conversion to generate the visible to mid-IR wavelength. Since the waveguide's efficiency is improved by two to three order of magnitude as compare to bulk device, such waveguide device is well suited for the generation of such UV to mid-IR light source for various applications ranging from bio-medical/DNA probing, UV-blue light source for next generation of HD-DVD pickup head and other commercially potential products that desire high conversion efficiency for flexible wavelength conversion with low input pumping and requires small physical footprint as well.

Waveguide

Standard





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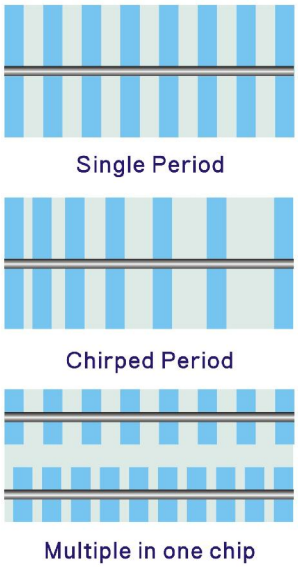
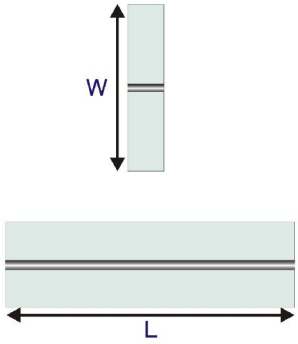
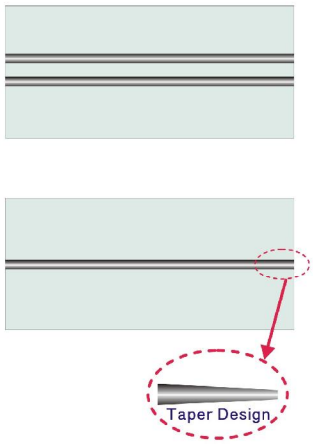
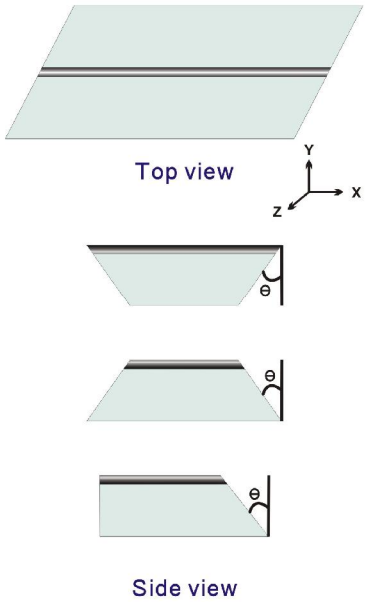
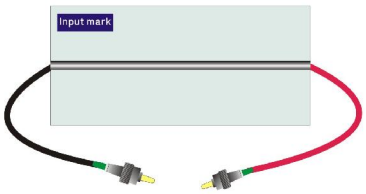
Optional

1. Full Spectrum 780nm SHG ~ 1580nm SHG (QPM Period: 2.0μm~60μm)	2. Length / Width (optional)	3. Channel Design (number, position...)
		
4.Flat / Angle Polish (Facet...)	**5.Fiber Pigtail**	**6.Oven... (TEC)**
	 **Packaging** Single-Side Pigtailing & Double-Side Pigtailing **Fiber Type** Single-Mode Fiber (SMF), Polarization Maintaining Fiber(PMF) **Connector** FC/PC, FC/APC & Others	

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Application		General Spec.
Telecommunication Bands SHG / SFG / DFG / χ^2: χ^2 Wavelength Conversion WG (also for ~780nm-Band Down-Conversion)	• Signal processing • Wavelength converter for telecommunication application Quantum processing • Single-photon counting and etc... • Narrow-linewidth “Red” light generation • Military application	• Dimension: 1~50mm-long SHG section 3~10mm-wide 0.5mm-thick • ≧ 80%/W/cm^2 conversion efficiency • ≦ 0.35 dB/cm propagation loss @ 1550nm • Flat/Angled-Polishing • Anti-Reflection / High-Reflection coating

RGB Generation WG	• RGB laser projector display
	• Laser printing
	• Optical storage
	• Biomedicine application:
	  ○ Bio imagining
	  ○ Optical Biopsy
	  ○ Light Activated Therapy
	  ○ Genomics/Proteomics Analysis
		• 900~1300 nm SHG
		• Dimension: Length: 5~25 mm Width: 3~10 mm Thickness: 0.5 mm
		• ≧ 200~500%/W/cm2 conversion efficiency
		• ≦ 0. 5 dB/cm propagation loss @ 900 nm
		• Flat/Angled-Polishing
		• Anti-Reflection / High-Reflection coating

Telecommunication Bands (SHG / SFG / DFG / χ^2: χ^2)
Wavelength Conversion Waveguide

Telecommunication Bands	Wavelength Range
O-Band	1260-1360nm
E-Band	1360-1460nm
S-Band	1460-1530nm
C-Band	1525-1565nm
L-Band	1565-1625nm
U-Band	1625-1675nm

Mechanical Properties

Property	Specification	Tolerance
Substrate material	1.2mol% MgO-doped Stoichiometric Lithium Niobate (MgO:SLN)	-
	Congruent Lithium Niobate (CLN)	
Length of QPM grating period	1~50 mm	-
Length of mode filter/taper	1~5 mm (one side)	-
Channel-to-channel separation	125 µm (Typical)	-
Crystal dimension L (length)	1~60 mm	+ 0.5 / - 0.5 mm
Crystal dimension W (width)	3~10 mm	+ 0.2 / - 0.2 mm
Crystal dimension T (thickness)	0.5 mm	+ 0.1 / - 0.1 mm

Nonlinear-Optical Properties

Property	Specification	Tolerance
Quasi-phase-matching wavelength (desired OF mixing wavelength or operation wavelength)	Depends on specification e.g. 1550 nm SHG 1510 nm+1610 nm SFG	± 0.5 nm
Quasi-phase-matching temperature (or operation temperature)	Depends on the specification 20~80 °C (Typical for PPMgO:SLN WG)	± 5 °C
	≧ 80 °C (Typical for PP CLN WG)	
Mode filed diameter (MFD) (consider the WG integrated with mode filter/taper section)	9.7 µm (Y) * 7.3 µm (Z), optimized for 1550nm-band	± 0.5 mm
	4.5 µm (Y) * 3.9 µm (Z), optimized for 775nm-band	
Propagation loss coefficient	≦ 0.25 dB/cm @ 1550 nm (PP MgO:SLN WG)	-
	≦ 0.35 dB/cm @ 1550 nm (PPCLN WG)	
Coupling efficiency	≧ 50% (Typical with AR coating @ 1550nm; 5cm long WG)	-
Normalized conversion efficiency	≧ 80 %/W/cm² (SHG Typical) (for 5cm long WG, the conversion efficiency will be ≧ 2000%/W)	-
Chip acceptance bandwidth (FWHM)	1 nm . cm @1550 nm	-
Temperature tuning coefficient	0.1 nm/°C	± 0.02 nm/°C

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RGB Wavelength Conversion Waveguide

Mechanical Properties

Property	Specification	Tolerance
Substrate material	5.0mol% MgO-doped Congruent Lithium Niobate (MgO:CLN)	-
	1.2mol% MgO-doped Stoichiometric Lithium Niobate (MgO:SLN)	
Length of QPM grating period	1~25 mm	-
Length of mode filter/taper	0.5~3 mm (one side) base on the customer design	-
Channel-to-channel separation	100 µm (Typical)	-
Crystal dimension L (length)	1~31 mm	+ 0.5 / - 0.5 mm
Crystal dimension W (width)	3~12 mm	+ 0.2 / - 0.2 mm
Crystal dimension T (thickness)	0.5 mm	+ 0.1 / - 0.1 mm

Nonlinear-Optical Properties

Property	Specification	Tolerance
Quasi-phase-matching wavelength (desired OF mixing wavelength or operation wavelength)	Depends on specifications e.g. 976 nm SHG; 1064 nm SHG	± 0.5 nm
Quasi-phase-matching temperature (or operation temperature)	20~80 °C (Typical)	± 5 °C
Propagation loss coefficient	≦ 0.5 dB/cm @ 976 nm ≦ 0.45 dB/cm @ 1064 nm	-
Coupling efficiency	≧ 60% with AR coating (single side) based on 2 cm QPM grating section WG	-
Normalized conversion efficiency	≧ 200~500 %/W/cm² (Typical SHG) (for 2cm long WG, the conversion efficiency will be ≧ 800~2000%/W)	-
Chip acceptance bandwidth (FWHM)	0.15 nm . cm @976 nm	-
Temperature tuning coefficient	0.1 nm/°C	± 0.02 nm/°C

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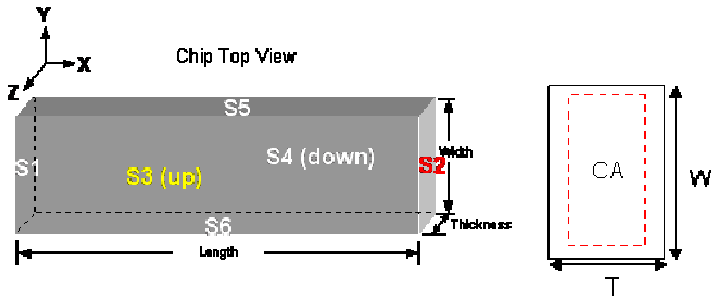
Dimensions



Mechanical Property

Property	Specification	Tolerance
Angle between S1 and S3	90.0°	± 0.2°
	Angle (customized)	
Angle between S1 and S5	90.0°	± 0.25°
	Angle (customized)	
Angle between S3 and S5	90.00°	± 0.25°
Parallelism between S1 and S2 (relative angle)	0.0°	< 0.1°
Parallelism between S3 and S4 (relative angle)	0.0°	< 0.1°
Parallelism between S5 and S6 (relative angle)	0.0°	< 1°
Chip-outs in S3, S4, S5 and S6	none extending >0.2 mm from any edge	none extending >0.2 mm from any edge

- The angle between S3 and S5 is defined by the dicing machine. The typical value is less than 0.25°.
- Parallelism between S3 & S4 (relative angle): < 1', checked by autocollimator.
- The angle between S5 and S6 is also defined by the dicing machine. The typical value is less than 1°.
- The parallelism (relative angle) between S1 & S2 is calculated by taking the difference between ∠S1S3 and ∠S2S3.

Optical Property

Property	Specification	Tolerance
Surface quality of S1 and S2 (scratch / dig)	-	20 / 10
Surface flatness of S1 and S2	λ/4 @ 633 nm	-
AR coating reflectivity on S1 and S2 for polarization parallel to the z axis	Depends on desired wavelengths and specifications For example of SHG : <0.5% at λ , <1% at λ/2	-

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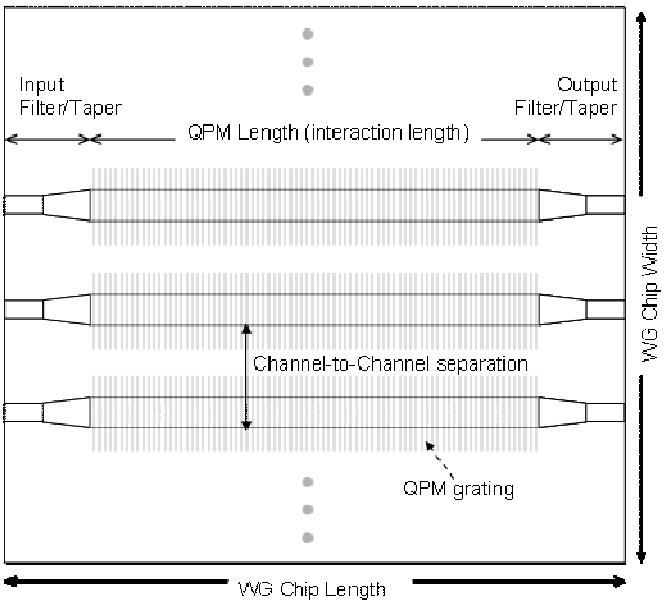
Structure



Pigtailing

Product Name	Product Applied	General Spec.
Epoxy Type Pigtailing Service	■Telecommunication Band Product ■Other Infrad-band application product ■Low power application (<20mW) ■Lab-demo level unit or prototyping device	**Fiber Type:** Single-Mode Fiber (SMF) Polarizatrion-Maintainance Fiber (PMF) **Standard Fibers:** Corning SMF-28e: SMF; mainly for 1300/1550nm-band wavelength Corning PM-1550: PMF; mainly for 1300/1550nm-band wavelength Corning PM- 850 : PMF; mainly for 775/850nm-band wavelength Corning HI-1060 : SMF; mainly for 976/1064/1550nm-band wavelength **Assigned/consigned fibers:** SMF-980; PM-488; SMF-775… **Fiber Length:** 1 Meter (Typical) **Connector Type:** FC/APC FC/PC
Epoxy-Free Type Pigtailing Service	■All WG Products ■High power application ■Lab-demo level unit or prototyping device	

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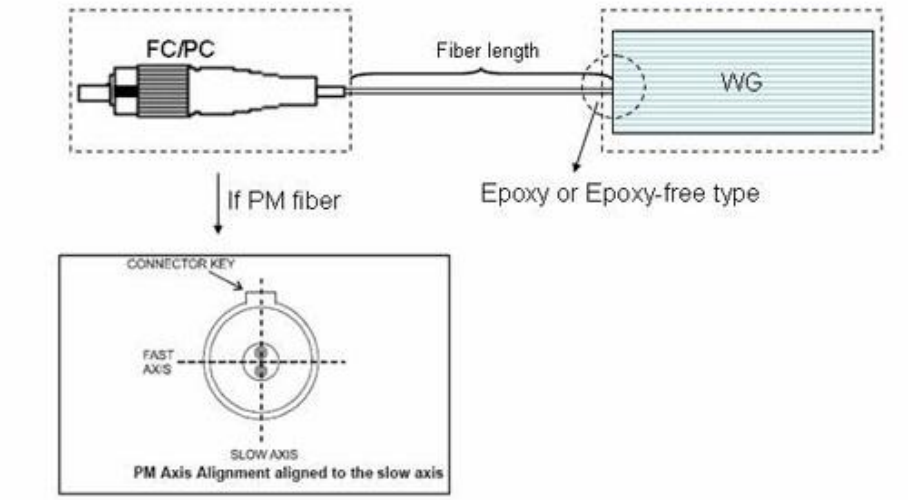
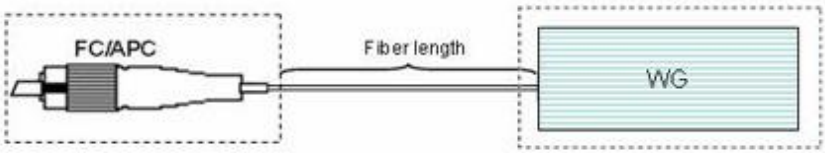
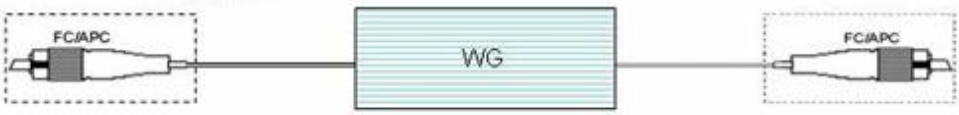
Single Side Pigtailing => FC/PC, PM fiber



Single Side Pigtailing => FC/APC, SM fiber



Double Side Pigtailing => FC/APC, SM fiber



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