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PPLN Waveguide Type

Q: What is the difference between proton exchanged (PE) and ridge waveguide?

A:

Proton exchanged/reversed proton exchanged (RPE) waveguide is formed by proton diffusion and buried waveguide technique. It has good potential for longer device (such as up to 50 mm long telecom band device) due to its relatively low loss properties (e.g. very good mode overlapping with typical single mode at 1550nm). However, the relatively lower power handing capabilities (such as < 20 mW for 780 nm output) and the experimentally measured low damage threshold (~70 kW/cm^2) limit its applications. Besides, the diffused protons only increase the cored refractive index for e-polarized wave, thus the o-polarized wave cannot be guided in PE/RPE waveguide.

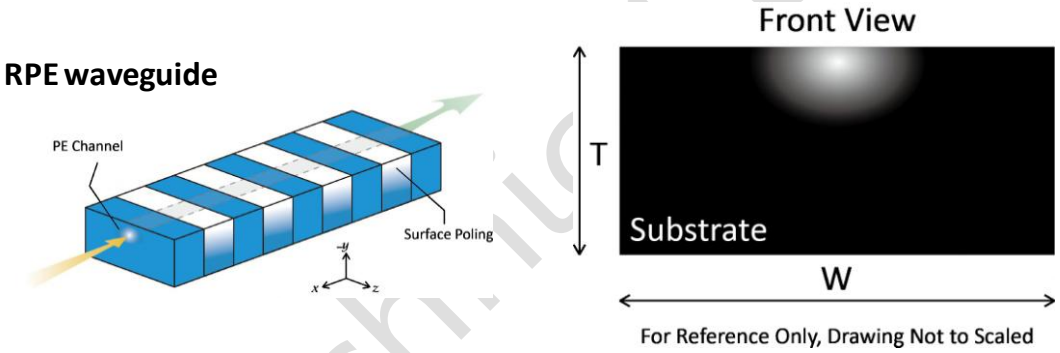

Fig. 1. The geometrical structure and cross-section view of RPE waveguide

Ridge structure waveguide form by precision dicing or etching on lithium niobate (without proton diffusion) has relatively higher power handling capabilities, such as > 200 mW at 532 nm output and >500 mW at 780 nm output. Most important of all, unlike the RPE waveguide, the o-polarized wave can be guided in the ridge waveguide.

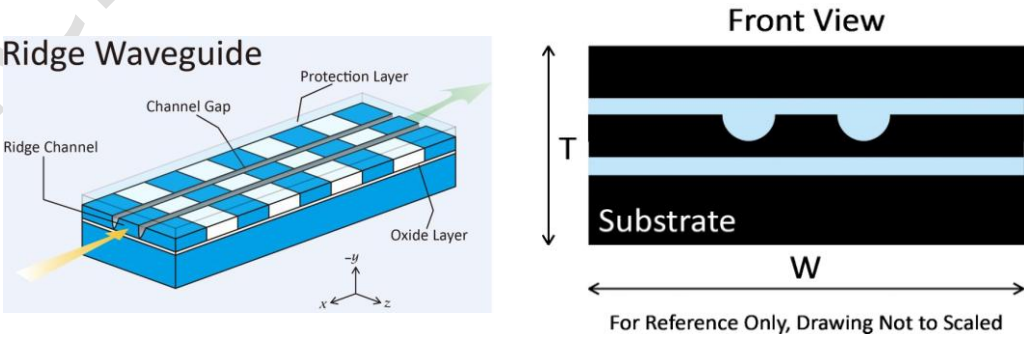

Fig. 2. The geometrical structure and cross-section view of ridge waveguide

Following table gives a comparison of optical power handling of the two type waveguides,

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assuming with single frequency pumping source.

Table 1. Examples of conversion efficiency and power handling for waveguides.

1064nm SHG	RWG	RPE
NCE (%/W-cm^2)[*1]	~250	~25
Power Handing@532nm	>200 mW	Few mW

1560nm SHG	RWG	RPE
NCE (%/W-cm^2)	~80	~15
Power Handing@780nm	>500mW	~20mW

[*1] The normalized conversion efficiency (NCE) for RPE waveguide is typically lower than the ridge waveguide due to the weak guiding of PE waveguide.

Reference:

[1] Digonnet, M., M. Fejer, and R. Byer. "Characterization of proton-exchanged waveguides in MgO: LiNbO 3." Optics letters 10.5 (1985): 235-237

[2] Glavas, E., J. M. Cabrera, and P. D. Townsend. "A comparison of optical damage in different types of LiNbO3 waveguides." Journal of Physics D: Applied Physics 22.5 (1989): 611.

[3] Jubera, M., et al. "Photorefractive effect and optical damage thresholds in z-cut swift heavy ion irradiation LiNbO3 waveguides."