Mid-Infrared SPDC in Lithium Niobate Waveguide

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Imaging and spectroscopy with undetected photons [1] provide a powerful route to enhance sensitivity in spectral regions where efficient detectors are unavailable, especially in the mid-IR where most molecules have their fingerprints [2,3]. Periodically-poled lithium niobate (PPLN) ridge waveguides [4] hold potential to increase photon generation rate in type-0 SPDC in the mid-IR. We have designed a 6.5 µm × 6.8 µm PPLN waveguide (see design in Fig. 1a) to generate a 1250 nm signal photon and a 3500 nm idler photon from a 920 nm pump. The poling period ensuring phase matching is $\Lambda = 19.6$ µm. Then, a 4-inch, 500-µm-thick z-cut congruent $LiNbO_3$ wafer underwent periodic domain inversion at room temperature using high-voltage poling through a patterned photoresist mask, defining poling period of 19.6 µm. After SiO_2 and Au deposition, the wafer was bonded to a metallized Si wafer, achieving >98 % bonding. The hybrid Si/PPLN stack was thinned and polished to a 6.5 ± 0.05 µm layer. Then, 6.8-µm thick ridge waveguides were cut with a precision dicing saw. The experimental setup (Fig. 1b) used an in-house built picosecond laser source delivering 3.7 ps pulses tuneable between 850 and 1050 nm, with 1 nJ energy at 67 MHz, coupled to the waveguide TM_{00} mode through a PM780 fiber [5]. With 44 mW incident pump power, 25 mW is measured at the output, indicating high coupling efficiency. The signal at 1250 nm (Fig. 1c) reaches 30 µW in the high parametric gain regime. The corresponding idler is expected to lie around 3500 nm. Further MIR results will be presented at the conference.

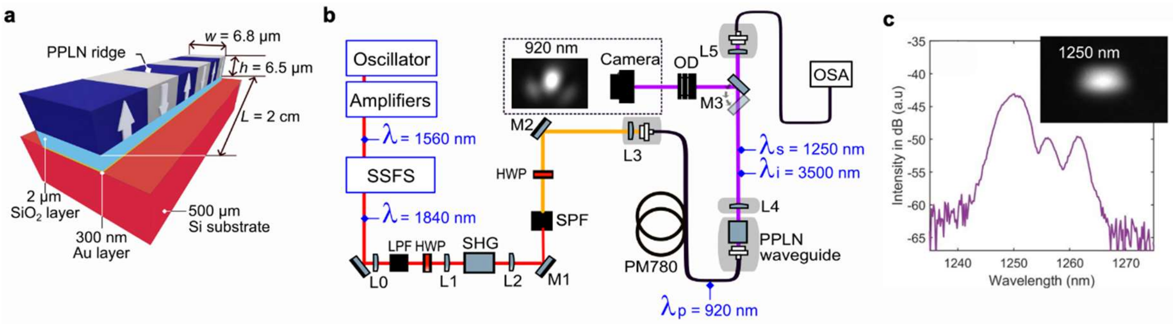

Fig. 1: *(a) Waveguide design. (b) Experimental setup. (c) Signal spectrum and near-field intensity.*

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