Broadband Biphoton Generation and Polarization Splitting in a Monolithic AlGaAs Chip

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Abstract. Integrated quantum photonics is a key tool towards large scale quantum technologies. In this work we present an AlGaAs-based photonic circuit for on-chip generation and manipulation of broadband orthogonally polarized photon pairs. Among different platforms used for the development of quantum photonic chips AlGaAs is extremely interesting for integrability. This material has a direct bandgap, enabling monolithic integration of active components and presents a large electro-optic effect that can be exploited for the manipulation of photonic states.

In this work, broadband orthogonally polarized photon pairs are generated by Type-II spontaneous parametric down conversion in AlGaAs Bragg reflection waveguides at telecom wavelengths and room temperature. We demonstrate that 85% of the pairs are deterministically spatially separated via their polarization over a bandwidth of 60 nm through a birefringent directional coupler. The performances of the device as a quantum photonic chip are assessed by implementing a Hong-Ou-Mandel interferometer at the chip output.

1 Introduction

Integrated quantum photonics is a key tool towards large scale quantum technologies. In this work we present an AlGaAs-based photonic circuit for on-chip generation and manipulation of broadband orthogonally polarized photon pairs. Among different platforms used for the development of quantum photonic chips AlGaAs is extremely interesting for integrability. This material has a direct bandgap, enabling monolithic integration of active components and presents a large electro-optic effect that can be exploited for the manipulation of photonic states.

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2 Sample layout

The device combines a Type-II parametric source of orthogonally polarized photons pairs followed by a broadband polarizing mode splitter. In this design, the splitting is achieved through a birefringent directional coupler which is based on evanescently coupled waveguides; by a careful design of an induced birefringence, photons of the pair are separated, following their different polarizations, in two different spatial modes (fig.1).

3 Results

We demonstrate a high efficiency of the polarization splitting region design with 85% of the pairs deterministically separated by the chip over a 60 nm bandwidth (fig.2). The performances of the device as a quantum photonic circuit are assessed by implementing at the chip output a Hong-Ou-Mandel interferometer, one of...
the most fundamental nonclassical experiments in quantum optics lying at the heart of many quantum logic operations; the obtained raw visibility is 75.5% for a 60 nm-broad biphoton state (fig.3). These results, obtained at room temperature and telecom wavelength represent a significant step towards real-world quantum photonic integrated circuits working in the broadband regime.

**References**

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