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ABSTRACT

Cavity Resonator Integrated Grating Filters are micro-structured integrated resonators that exhibit resonances with Q factors in order of a thousand and that can be excited with focussed beams. These two characteristics make them particularly attractive as base components for non-linear optical generation. In this contribution, we experimentally demonstrate second harmonic generation in such devices under continuous wave excitation and show that the measured performance are in good agreement with theoretical predictions.

Keywords: non-linear optics, micro-resonator, subwavelength gratings.

1. INTRODUCTION

Cavity Resonant Integrated Grating Filters (CRIGF) were introduced by Prof. Ura's team in 2012[1] and have thus been thoroughly investigated by different teams. They allow narrow-band and efficient spectral filtering under tightly focused excitation [2], and can achieve polarization independence [3], and can be finely tuned by variational design [4], [5]. They have been demonstrated in different wavelength ranges from the near-infrared [2] to the mid-infrared [6]. It has now been shown that their intrinsic properties stem from the excitation of a localized mode of high Q factor localized under the main grating coupler [7] (see fig.1).

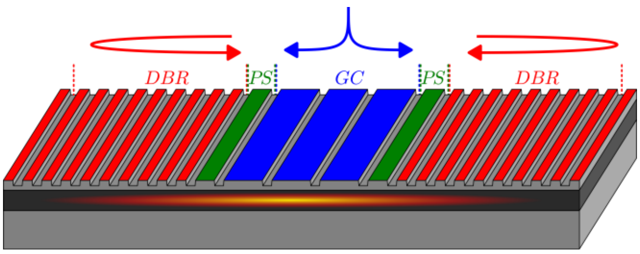

Figure 1. schematic of a CRIGF highlighting its different parts : grating coupler (GC, blue), phase sections (PS, green) and distributed Bragg reflectors (DBR, red).

This localized mode with a high Q factor can be interesting for non-linear optical operations such as second harmonic generation (SHG) as it provides strong optical field enhancement within a small volume. We have recently demonstrated such SHG in these devices when made on a thin film of Lithium Niobate, a well-known material for its non-linear optical properties [8]. In this paper, we will detail recent experimental results obtained on such devices.

2. RESULTS

Samples are fabricated on a NanoLN-provided wafer made of a $LiNbO_3$ substrate, a 2.3-µm-thick SiO_2 spacer and a thin, 300-nm-thick $LiNbO_3$ film oriented along its Z-cut direction. The grating layer was made of a 70-nm-thick Si_3N_4 layer deposited using low-temperature ICP-PECVD deposition. Electron-beam lithography was used to define the grating structures in a 130-nm-thick PMMA resist. After development, RIE dry etching was performed using a CHF_3/O_2 chemistry. It should be noted that the $LiNbO_3$ layer acts as a stop etch during this fabrication step, resulting in smooth, homogeneous etching base. As a last step, a 460-nm-thick SiO_2 capping layer was deposited using once again ICP-PECVD. This capping layer results in a low-reflectivity stack around the target pump wavelenght of 1.55 µm. For this wavelength of operation and the stack described above, the GC period is around 865 nm, with a DBR period half that of the GC.

The fabricated CRIGF exhibited sharp resonance peaks around 1.55 µm, and the SHG generation was found to follow exactly the resonances, as shown on figure 2.

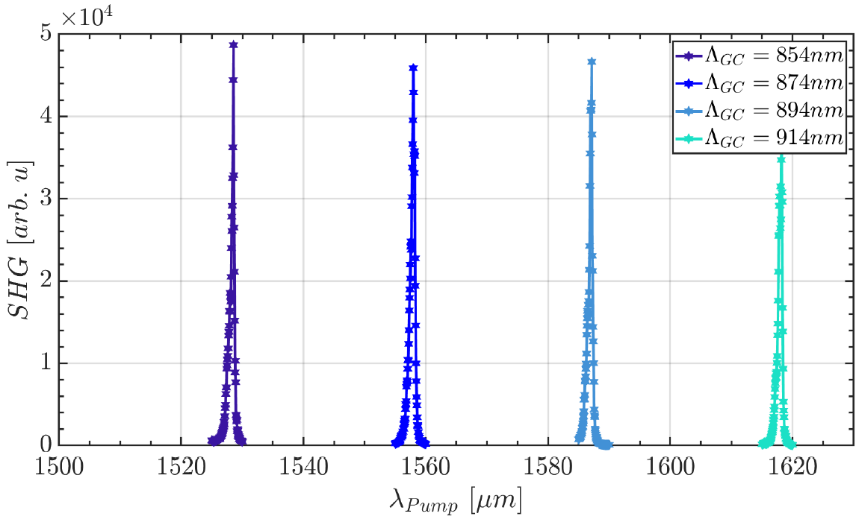

Figure 2. Evolution of the SHG intensity with the pump wavelength for 4 different CRIGF periods indicated in the inset.

We will present results achieved on these filters and compare them to theoretical results. Routes towards higher SHG efficiency will also be presented.

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