Low noise continuous wave tunable laser from 616 nm to 637 nm based on a compact sum frequency generation setup

Ruizhe GU[1], Dia DARWISH[2], Germain GUIRAUD[2], Mathieu CHAUVET[3], **Coline MAHOB[4], Christof JANSSEN[4], Giorgio SANTARELLI[1], Adèle HILICO[5]**

1. LP2N, IOGS, CNRS and Université de Bordeaux, rue François Mitterrand, 33400 Talance, France

2. Toptica Photonics SAS, 11 Avenue de Canteranne, 33600 Pessac, France

3. Université de Franche-Comté, 1 Rue Claude Goudimel, 25000 Besançon, France

4. Sorbonne Université, CNRS, MONARIS, 75252 Paris, France

5. Laboratoire de Physique des Lasers, Université Sorbonne Paris Nord, CNRS, 93430 Villetaneuse, France

Adele.hilico@univ_paris13.fr

RESUME

L'objectif du présent article est de présenter un prototype de laser accordable du rouge au orange produisant 1W de 616 à 637nm, réalisé par somme de fréquence de sources infrarouge à 1 et 1.5μm. La somme est réalisée dans un cristal PPLN réalisé à façon. Les sources infrarouge sont combinées de manière fibrée et l'accordabilité est réalisée en modifiant uniquement la température d'accord de phase. Le cristal est en effet constitué de deux canaux successifs possédant deux périodes différentes, augmentant l'accordabilité.

MOTS-CLEFS : *laser, laser visible, laser accordable, PPLN, SFG*

1. INTRODUCTION

Our group previously developed a high-power, low-noise, tunable single-frequency laser system emitting in the range of 616.5 nm to 630.8 nm, utilizing sum frequency generation (SFG) of high power 1 and 1.5µm sources in a 5% magnesium oxide (MgO)-doped periodically poled lithium niobate (PPLN) crystal under type-0 quasi-phase matching (QPM) configuration [1]. In this configuration the infrared (IR) source beams were prepared independently and the tunability was achieved by changing the temperature and the channel of the crystal, requiring a mechanical displacement.

2. WORK

Recently, we worked on the compacity of the system, and extended the tunable bandwidth to 616 nm–637 nm using a customized MgO:PPLN crystal featuring two periodicities integrated into a single channel. The extended tunability is achieved by temperature control only, without requiring additional mechanical movement.

As shown in **Fig. 1** (a), continuous tuning across the entire bandwidth is realized by varying the crystal temperature from room temperature to 250°C, seamlessly transitioning between periodicities. The system delivers an average output power at the watt level across the full wavelength range (**Fig. 1** (b)) with excellent stability over a 10-hour operation period (**Fig. 1** (c)).

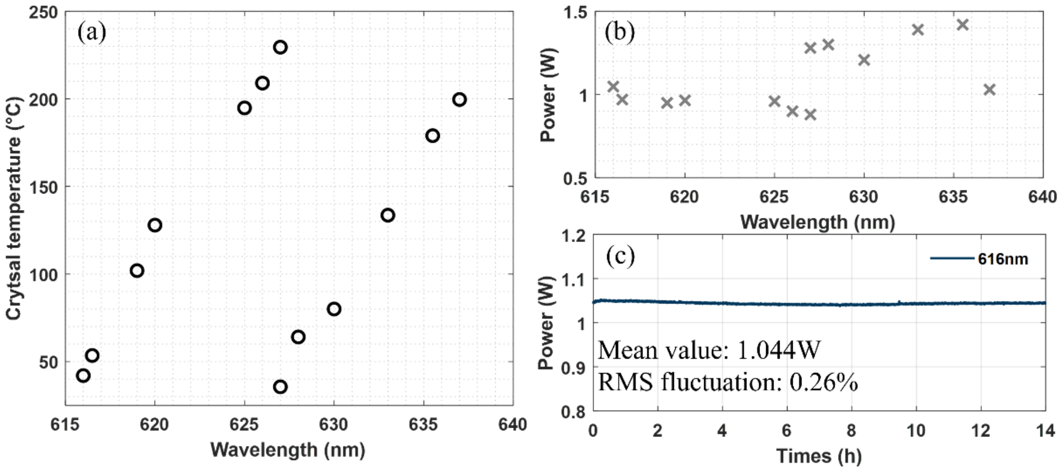

Fig. 1 (a) Phase matching temperature v.s. wavelength in red regime. (b) Red power measured for different wavelength within the tunable bandwidth for 14W of IR pumps. (c) Endurance of power at 616 nm oven 10-hour operation.

With its energy levels positioned in the visible range, this system is highly suitable for replacing CW dye lasers, realize spectroscopy of molecules [2] or address specific atomic transitions, and for tunable UV generation. In particular, the accessibility of 616 nm enables the generation of 308 nm through a second harmonic generation (SHG) process. This specific UV wavelength holds significant potential for applications in atmospheric ozone investigation [3].

References

[1] D. Darwich et al., "High power ultralow-intensity noise continuous wave laser tunable from orange to red," Opt. Express, vol. **30**, no. 8, p. 12867 (2022)

[3] B. Gmeiner, et al., "Spectroscopy and microscopy of single molecules in nanoscopic channels: spectral behavior vs. confinement depth," Phys. Chem. Chem. Phys., vol. **18**, no. 29, pp. 19588–19594, (2016)

[4] J. Orphal et al., "Absorption cross-sections of ozone in the ultraviolet and visible spectral regions: Status report 2015," Journal of Molecular Spectroscopy, vol. **327**, pp. 105–121 (2016)