TeraXion
An indie Semiconductor Company

FBG reflectors for kW fiber lasers at 2 microns

Application Note

In recent years, the market for 2 µm high-power fiber lasers has witnessed remarkable expansion, driven by the emergence of diverse applications. Consequently, there is now a pressing demand for highly reliable and high-performance FBG reflectors as will be discussed in this application note.

Introduction

Fiber lasers operating within the 2 µm wavelength range are rapidly finding utility in a diverse array of applications, including medical surgery, solid-state laser pumping, light detection and ranging (LiDAR), materials processing, free space communication, and infrared countermeasures (IRCM). As will be shown in this note, certain applications necessitate high-power fiber lasers, but due to component limitations in this wavelength range this poses several challenges to produce such lasers.

Applications

- Medical
- Defense
- Laser pumping
- LIDARs
- Free-space communications

Applications for high-power fiber lasers at 2 µm

The significance of fiber lasers has been growing steadily, particularly in medical applications, where they are increasingly replacing older laser technologies and conventional non-laser procedures. Notably, the urology market segment stands out as the most crucial market for 2-micron fiber lasers. Thulium fiber lasers operating at 1940 nm are progressively supplanting solid-state lasers in surgical procedures like lithotripsy or benign prostatic hyperplasia.

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Additionally, 2 µm fiber lasers hold immense potential in various defense applications, offering distinct advantages such as favorable atmospheric transmission, reduced scattering, and enhanced eye-safety during operations involving friendly forces or bystanders. Some of these applications necessitate high average or peak power at kW levels yet achieving such power levels at 2 µm remains a challenging endeavor, as we will explore further below.

FBG reflectors for kW fiber lasers at 2 µm

Scaling power levels beyond the kilowatt range has posed significant challenges for 2 µm fiber lasers, primarily due to the heating effects observed in laser components, particularly in FBG reflectors. This limitation has restricted output powers to only a few hundred watts as excessive FBG heating can lead to catastrophic failures, as illustrated in Figure 1, with burnt or broken FBG fibers.

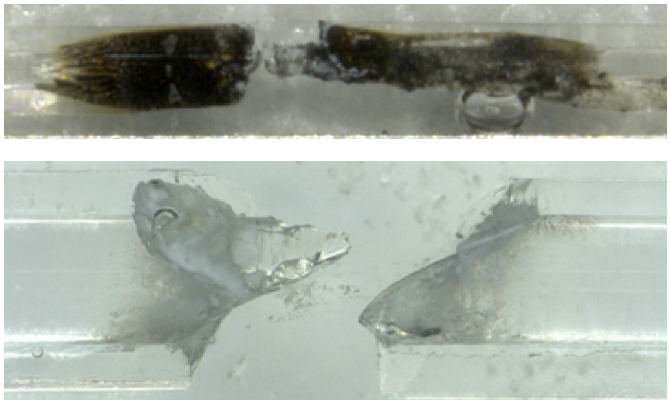

Figure 1. Catastrophic failures from excessive FBG heating resulting in burnt (top) or broken (bottom) FBG fiber.

At the 1 µm wavelength, FBG reflectors have proven their reliability at kilowatt power levels, benefiting from well-established technology.

However, to ensure safe and dependable high-power operation at 2 µm, specialized FBG reflectors meticulously designed and manufactured for this wavelength become indispensable. TeraXion's kW Class or Med-2 series of FBG reflectors are specifically made to meet these requirements. These FBG reflectors are produced using TeraXion's unique manufacturing process, significantly mitigating heating effects (by up to a factor of 10!) and enabling output powers of over 1 kW, as depicted in Figure 2.

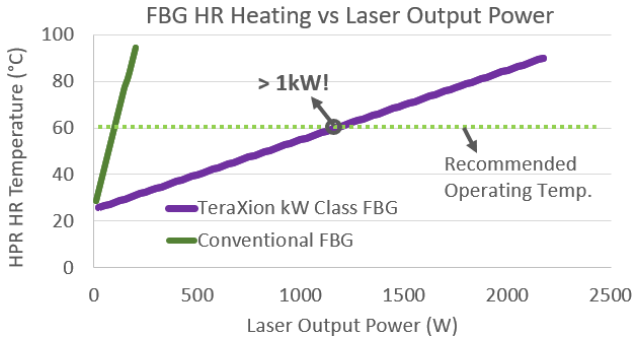

Figure 2. Power handling performance of kW class versus conventional FBG reflectors

Using TeraXion's kW Class or Med-2 series of FBG reflectors also results in a more controlled wavelength shift, which is a crucial parameter that can significantly impact laser operation and performance.

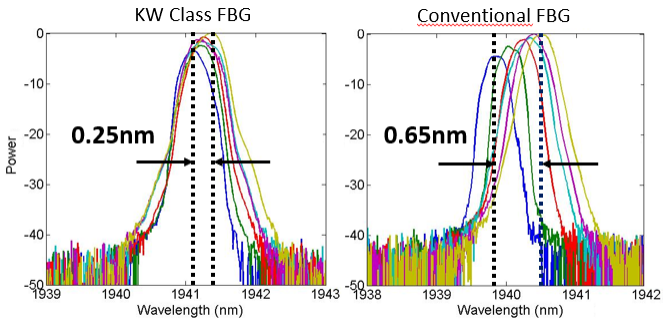

Figure 3. Measured wavelength shifts over 40W of laser output power for kW Class vs conventional FBG.

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Conclusion

The surge in demand for high-power fiber lasers at 2 µm has been remarkable, yet the road to achieving such power levels at this wavelength is riddled with challenges posed by component limitations. Notably, FBG reflectors have been prone to heating effects, thereby restricting their power handling capabilities. To ensure a safe and dependable high-power operation, the selection of FBG reflectors specifically engineered for this wavelength becomes paramount. TeraXion's kW Class or Med-2 series of HPR FBG reflectors stand out as ideal choices, benefiting from a unique manufacturing process that effectively curtails heating effects by up to a factor of 10! By embracing these advanced solutions, the prospect of attaining powers beyond 1 kW becomes a reality, marking a significant advancement in the domain of 2 µm fiber lasers.

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