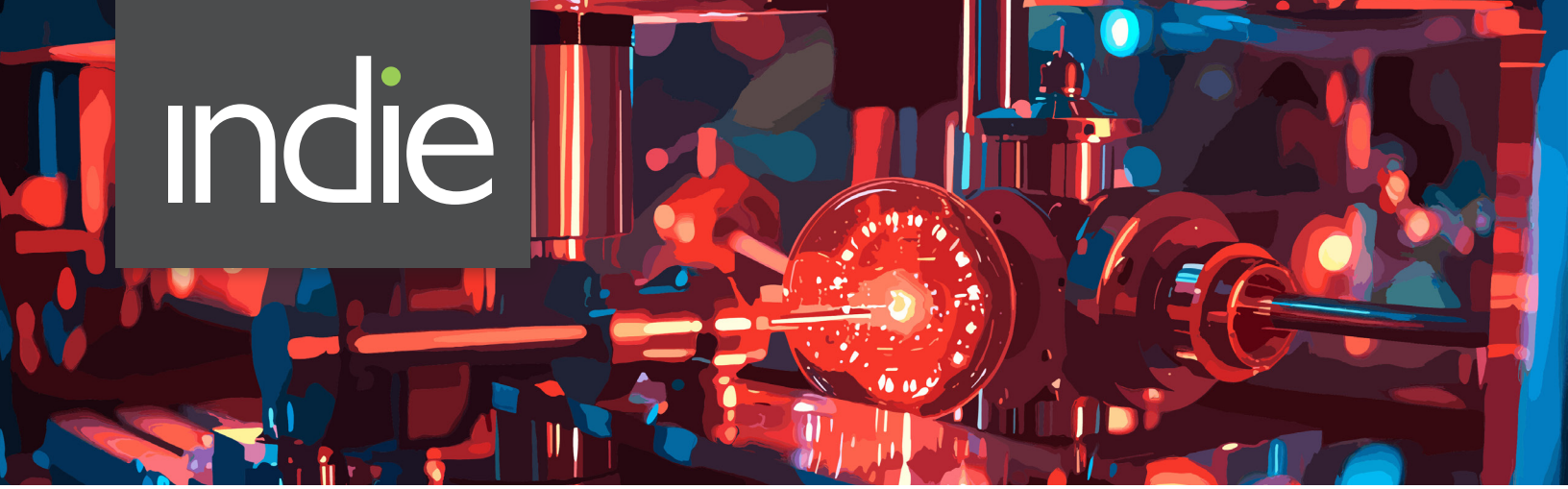

FBGs for Laser Diode Wavelength Locking

Michel Bégin, M. Sc. A., Product Line Manager - Fiber Lasers, indie

Fiber Bragg Gratings (FBG) are used in many applications requiring semiconductor lasers with high wavelength accuracy and stability. FBGs offer several advantages such as high thermal stability, ease-of-integration, and versatility as will be discussed in this application note.

Introduction

Narrow linewidth and wavelength stabilized lasers play a vital role across various applications and industries, including sensing, medical, spectroscopy, imaging, and telecommunications. Although Distributed Bragg Reflector (DBR) or Distributed Feedback (DFB) lasers have excellent performances, they are more costly to produce than Fabry-Perot laser diodes as they necessitate individual testing before packaging. Furthermore, compared to waveguide gratings used in DFB and DBR lasers, FBGs exhibit superior stability and wavelength precision. Volume Bragg Gratings (VBGs) may be an alternative to FBG in some applications, but FBGs offer several advantages such as thermal stability, simplicity of integration, and versatility.

FBGs for Pump Wavelength Locking

Semiconductor pump lasers with high output power and stable wavelength play a crucial role in modern fiber lasers and amplifiers as well as in Raman fiber amplifiers. Given the amplifying gain medium's sensitivity to pump wavelength fluctuations, the market predominantly favors the use of Fiber Bragg Grating stabilized semiconductor pump lasers. A typical configuration of a FBG locked pump laser module is shown in Figure 1. For this application, the FBG is inscribed in the pump laser pigtail and typically positioned at a distance ranging from 50 cm to 2 meters.

Collimating optics or lensed fiber pigtails are used to couple light from the semiconductor laser emitter into the single mode fiber pigtail with high efficiency.

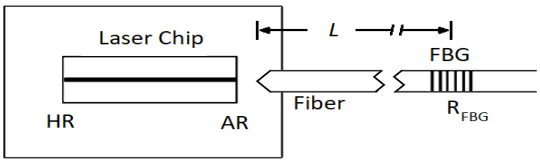

Figure 1: Typical FBG locked pump laser module

Fiber Bragg gratings are used to establish an external feedback mechanism, effectively stabilizing the laser wavelength near the central wavelength of the FBG and reducing the laser output spectral width. As a result, both high pumping efficiency and exceptional stability of the pump laser module can be achieved.

FBGs for Laser Wavelength Stabilization

The use of a Fiber Bragg Grating to create an external cavity laser provides a cost-effective means of enhancing the performance of low-cost lasers. As illustrated in Figure 1, the FBG is written in the fiber pigtail and typically positioned close to the emitter to form an external cavity laser.

In addition to delivering narrower linewidths compared to standard Fabry-Perot laser diodes, external cavity lasers with an FBG exhibit reduced susceptibility to wavelength shifts induced by variations in temperature or drive current, which are common sources of deviation in laser diode performance.

FBG Selection and Key Paramaters

To ensure that laser diode wavelength locking or stabilization is both efficient and reliable, laser diode manufacturers need to look for FBGs that fulfill essential performance criteria. Figure 2 outlines key FBG specifications with tolerances that are required to achieve proper operation.

Laser diode manufacturers should also select a reliable and well-established FBG supplier that can provide a large selection of FBG wavelengths and configurations (fiber types, PM or non-PM, dimensions, etc.).

Optical Parameter	Specifications	Tolerances	Units
Center Wavelength	700 - 1700	± 0.1	nm
Reflectivity	3 - 20	± 15%	%
Bandwidth (FWHM)	0.08 - 2	± 10%	nm
Side Mode Suppression Ratio	> 13	N/A	dB

Figure 2: Key FBG parameters and tolerances

For instance, the WaveLock series of wavelength lockers from indie offer excellent performances in terms of wavelength accuracy, bandwidth, side mode suppression ratio, and insertion losses. A typical transmission spectrum of a WVL FBG from indie is illustrated in Figure 3 below.

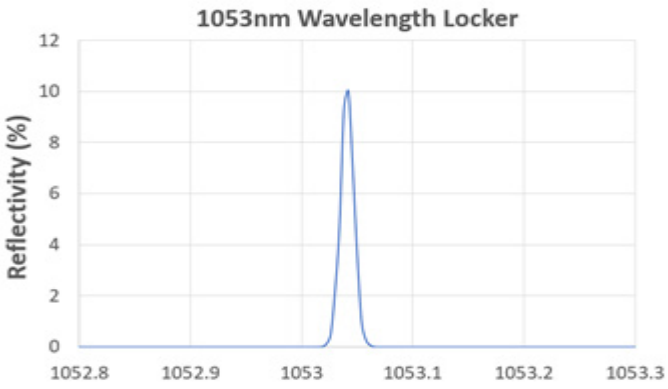

Figure 3: WVL typical transmission spectrum

Conclusion

Fiber Bragg Gratings are used in many applications requiring semiconductor lasers with high wavelength accuracy and stability. FBGs offers several advantages such as high thermal stability, ease-of-integration, and versatility. indie has released the WaveLock series of FBG wavelength lockers that offer excellent performances in terms of wavelength accuracy, bandwidth, side mode suppression ratio, and insertion losses.