SOA Semiconductor Optical Amplifier

Brief overview of the article: Classification, gain saturation, and noise characteristics of semiconductor optical amplifiers.

Semiconductor laser amplifier(SOA)

1. Classification of SOA semiconductor optical amplifiers

F-P SOA: It is essentially a semiconductor laser biased below the threshold. There is significant reflection on the end face. Photons travel back and forth in the laser cavity many times, which can obtain a large gain, but the gain bandwidth is narrow (basically an F-P cavity longitudinal mold line width).

2.Traveling wave SOA: The essence is to carry out anti-reflection design on the dissociation surface of the semiconductor laser. The incident signal only undergoes single-pass amplification, so it requires high gain, which is achieved by the high drive current of the amplifier. The gain bandwidth is large and the temperature stability is better than FP

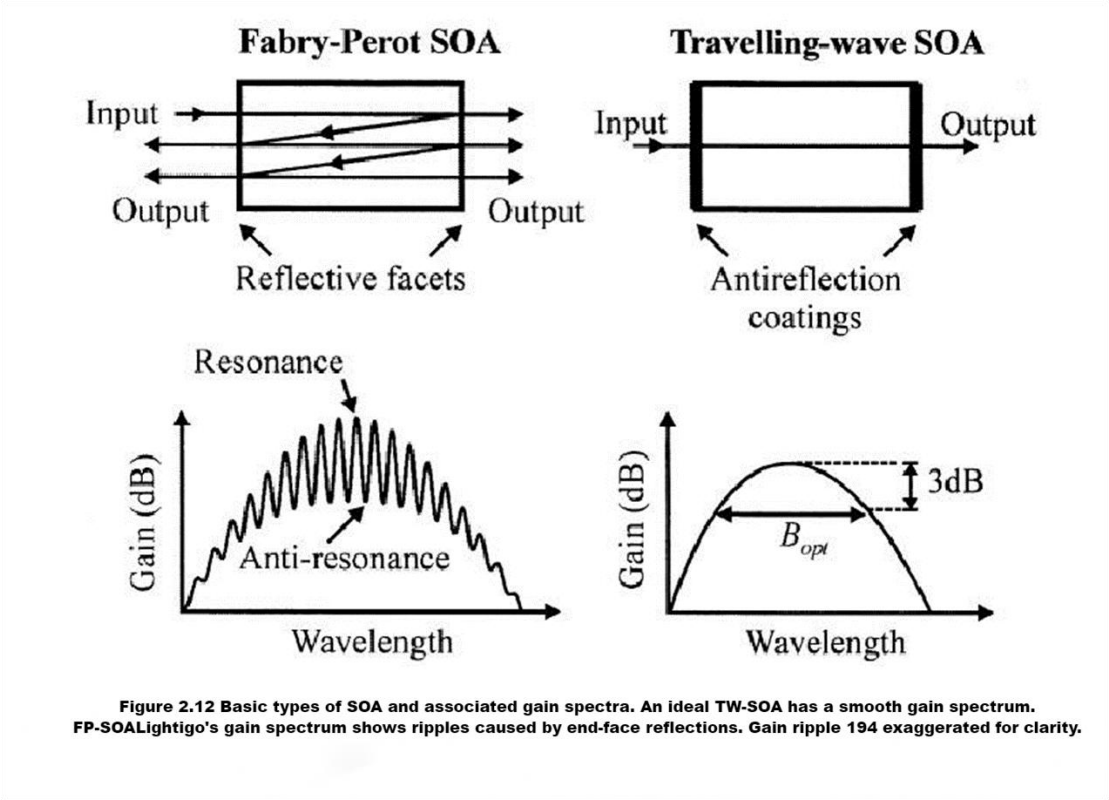

Figure 2.12 Basic types of SOA and associated gain spectra. An ideal TW-SOA has a smooth gain spectrum. FP-SOALightigo's gain spectrum shows ripples caused by end-face reflections. Gain ripple 194 exaggerated for clarity.

2. Gain saturation of semiconductor optical amplifier

The output energy of high-power semiconductor optical amplifiers is limited by saturation energy and amplified spontaneous emission.

Gain saturation energy:

$$E_{sat} = \frac{h\nu A}{(\partial g/\partial N)\Gamma}$$

hv is the photon energy, A is the active area area, ∂g/∂N is the differential gain, and Γ is the light confinement factor. It can be seen from the formula that the output energy can be increased by increasing the active area surface body, or reducing the differential gain and light confinement factor.

Gain saturation:

When the input optical power is constant, the gain increases as the concentration of injected carriers increases, but when the concentration of injected carriers is too large, the gain will be saturated or even decrease; when the concentration of injected carriers is constant, the output power increases with the concentration of injected carriers. However, when the input optical power is too large, the carrier consumption rate caused by stimulated emission is too large, resulting in gain saturation or decrease.

Causes of gain saturation:

The electrons and photons in the SOA active area material interact, whether they are photons generated inside the gain medium or external photons. The stimulated radiation caused by them consumes carriers at a rate consistent with the timely replenishment of carriers to the corresponding energy level. related to speed. In addition to stimulated emission, the carrier rate consumed by other factors will also change, thus adversely affecting the gain saturation of the SOA.

3. Noise characteristics of semiconductor optical amplifiers

Noise characteristics: The noise of SOA is mainly due to the random fluctuations in light intensity and phase caused by the interaction of electrons and photons in the gain medium. Described by the noise index, the main noise source is the beat noise formed between the signal light and the beat noise and spontaneous emission components of amplified spontaneous emission (ASE).

Impact of noise: ASE noise in SOA will not only worsen the noise characteristics of cascaded SOA, but also reduce the saturated output power of a single SOA.

Measures to reduce SOA noise: The reflectivity of the end face (especially the input face) should be minimized and

The loss coefficient of a gain medium waveguide.