生物から半導体にわたるナノ構造デバイスの発光吸収反射定量計測

Quantitative optical-response measurements of biological and semiconductor nano-devices

Objectives

生物化学発光の光量計測や、量子細線半導体レーザーのモード吸収利得値計測など、発光の相対強度計測しか通常行われてこなかった種々のナノ構造デバイスに対して、定量計測法の技術開発とその適用を行う。酵素タンパク質に依存したホタル生物発光の量子収率計測を推進し発光色決定機構の理解を目指す。また、量子細線レーザーの利得評価を経て、低しきい値発振を目指す。

Quantitative or absolute-value optical measurements are important for a wide range of nano-systems, such as emission yields of chemi- and bio-luminescence systems and modal gain or absorption in quantum nano-structure optical devices. We develop techniques of quantitative measurements of emission, gain/absorption, and reflection for small and novel nano-structure devices, and apply these techniques to investigate the fundamental material properties and physics of nano-structure devices.

Achievements

- ハッキパオリキャシディーの方法や導波路透過計測の方法をデバイス端面反射率制御と組み合わせて、量子井戸及び細線半導体レーザーデバイスに対してモード吸収利得を定量評価するいくつかの互いに相補的な手法を確立した。
- 高品質量子細線レーザー素子のモード吸収利得や内部損失を定量評価し、定量的物理モデルと比較することができるようになった。
- 生物発光の代表とも言える北米産ホタル生物発光の量子収率評価を行い 41±7%(k=1)の値を得るとともに色変化の定量分析に成功した。

- Several techniques to measure modal gain and absorption of nano-structure lasers were developed and applied to quantum well and quantum wire laser systems.
- Internal loss and modal gain properties of these lasers were characterized, and compared with quantitative model calculations.
- Bioluminescence spectra of North American firefly were measured quantitatively to evaluate a quantum yield value of 41±7% (k=1). Color change with pH due to pH-sensitive green emission was revealed.

Fig. 1

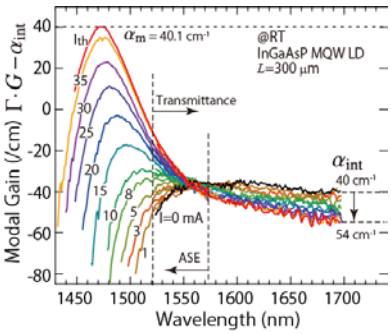

Fig. 2

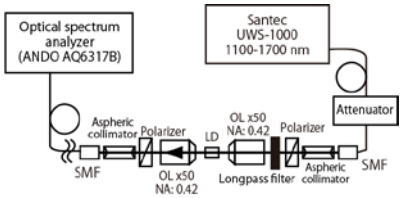

Fig. 1: Modal gain spectra of an InGaAsP long-wavelength MQW laser for a wide range of injection currents.
Fig. 2: Setup for the measurement of modal absorption and gain of long-wavelength semiconductor lasers.

Fig. 3

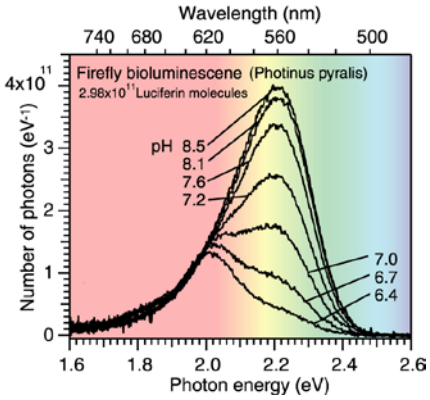

Fig. 3: Quantitative spectra of firefly bioluminescence to characterize quantum yields and color change with pH.

References

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