InAs quantum dot superluminescent diodes with trench structure

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Superluminescent diodes (SLDs) with high output power and broaden spectral bandwidth features are applicable for light sources of optoelectronic systems such as optical coherence tomography, optical time-domain reflectometers, and fiber-optic gyroscope. SLDs utilizing energy bandgap engineering based on multiple quantum wells (MQWs) have extensively used as an elastic way to effectively obtain high power and simultaneously broaden spectral bandwidth. Recently, SLDs based on quantum dot (QD) as active layer (QD SLDs) were demonstrated showing wider spectral bandwidth which resulted from inherent inhomogeneous spectral broadening due to QD size distribution.To further increase the spectral bandwidth, chirped multiple QD (CMQD) layers which have different energy bandgap per layer(s) has been suggested.

High optical power without any expense of bandwidth is another key issue on the SLDs. SLDs with strong index guided waveguide, i.e. deep etched ridge type waveguide (strong SLDs) might show higher output optical power than those with weak index guided one, i.e. shallow etched ridge type waveguide (weak SLDs). However, in the case of strong SLDs, there might be border line between SLDs and laser diodes (LDs) and thus sometimes SLDs fabricated for the purpose of the strong SLDs work not as SLDs but as LDs. This problem might be serious and needs tight device processes which might become reason for high cost. On the other hand, although weak SLDs do not suffer from such problem, they have still another problem of low optical power.

In this study, we report on the QD-based weak SLDs with trench structure. The waveguide type of the SLDs was J-shaped. The trench was formed along just outer side of J-shaped waveguide with separation between the trench and the waveguide. As the separation is short, that is, the trench is close to the waveguide of the weak SLDs, the optical power is increased to the same level as that of strong SLDs without any expense of spectral bandwidth. It is explained that the high optical power in the weak SLDs is obtained because the trench prevents the optical power loss from occurring at the bended region of J-shaped waveguide. We believe that such weak SLDs with trench structure are more cost-effective or reliable than strong SLDs.

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