Cylindrical WG 형태의 CdSe 양자점에서의 광 이득 향상과 saturation에 대한 해석

Modal gain enhancement by cylindrical waveguide and gain saturation in CdSe nanocrystal quantum dots

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Currently, enormous interest is arising in semiconductor NQDs as a gain medium regarding the various advantages such as fine wavelength tunability, size homogeneity, temperature insensitivity, low threshold, and low-cost synthesis. The intrinsic optical gain in NQDs was known to originate from multiexcitons such as biexcitons[1], but non-radiative Auger recombination severely limits transient gain lifetime. A couple of ideas have been proposed against this intrinsic obstacle such as reducing the Auger rate with elongated NQD structure and repulsive exciton-exciton interaction in type-II core-shell structure. The intrinsic gain has been studied[2], qualitative analysis of modal gain is also required for practical applications. The VSLM is widely used for optical modal gain measurement for its convenience. However, analysis of modal gain has been limited in the non-saturation regime due to ignorance of length-dependence of the modal gain. So we have pointed out length-dependence of modal gain saturation. Additionally, NQDs can be easily incorporated with various geometric cavities. These are useful to combine NQDs gain medium with an optical cavity that provides positive feedback as well as optical mode-connement. This may give rise to enhancement of modal gain and steady lasing. In this work, high density and quantum yield colloidal CdSe NQDs are prepared in a glass capillary to keep the uniform size distribution and prevent agglomeration of the particles. The film structure was also prepared with the same NQDs as a reference. We found that optical modal gain is significantly enhanced in the cylindrically-waveguided NQDs near the threshold excitation(~ 3.5 mJ), in which mere modal gain is seen in the film structure. Also, length-dependence of modal gain saturation was found to be suppressed above the threshold excitation (~ 5.5 mJ)

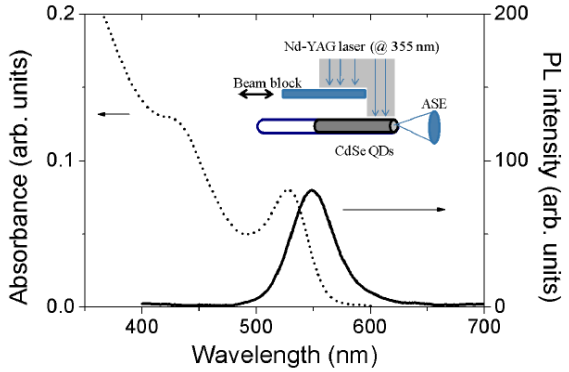

그림 1 Schematic diagram of the VSLM, and spectra of absorbance and PL

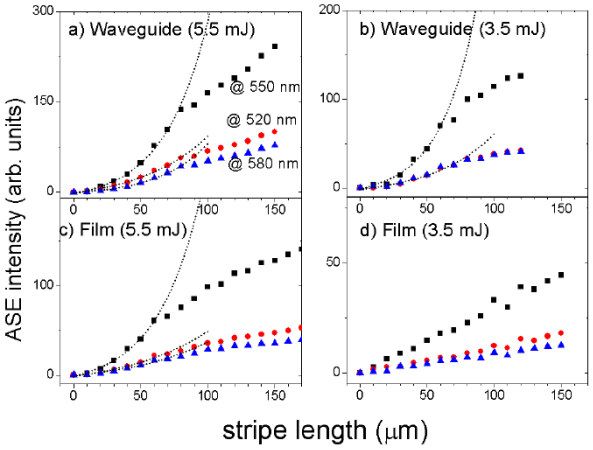

그림 2 Stripe-length dependent ASE intensities at various wavelengths in a waveguide and a film

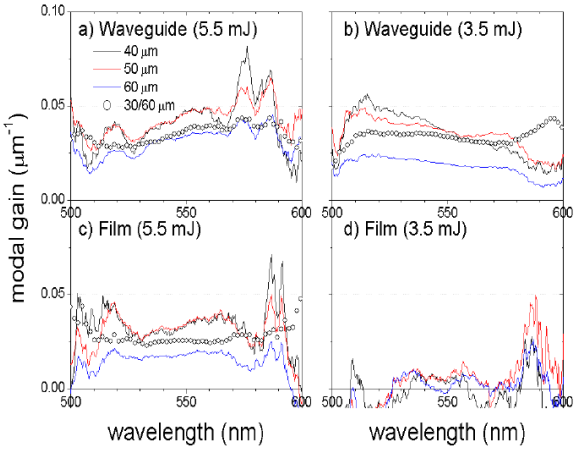

그림 3 Modal gain spectra of cylindrical waveguide structure film structure NQDs

참고문헌

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(2) L. Pavesi, L. D. Negro, C. Mazzoleni, G. Franzo, and F. Priolo "Optical gain in silicon nanocrystals" Nature 408, 440 (2000)