InGaAs/GaAs 積層量子ドットナノワイヤにおける プラズモニックファブリペローモードの観測

Observation of plasmonic Fabry-Perot modes in a GaAs nanowire embedding multi-stacked InGaAs/GaAs quantum dots

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Nanolasers are crucial components for the on-chip integration of nanophotonics and electronics with low power consumption. The miniaturization of lasers to scales comparable to that of electrical components is an on-going effort, and plasmonic nanowire (NW) lasers are a promising candidate to achieve this goal. Having demonstrated a plasmonic NW laser based on bulk GaAs dispersed on an ordered silver thin film [1], we now try to incorporate multi-stacked InGaAs/GaAs quantum dots (QDs) into the NWs as a gain medium in order to achieve better high temperature device performance [2]. In this presentation, we report the first observation of the emission of such multi-stacked QD structures into plasmonic Fabry-Perot modes.

The NWs used in this study are similar to that reported in ref. 2, comprising of 100 $In_{0.22}Ga_{0.78}As$/GaAs QD (diameter ~ 40 nm, height ~ 7 nm) stacks in GaAs NW with average length and diameter of 4 μm and 160 nm, respectively. The entire NW is coated in an AlGaAs shell to prevent surface recombination. The NWs are dispersed on a silver film as shown in Fig. 1a, and low temperature (8 K) micro-photoluminescence experiments were performed with a CW He-Ne laser as an excitation source. As a control sample, NWs dispersed on SiO_2 have typical power-dependent spectra shown in Fig. 1b. Broad Gaussian-like emission is seen as NWs in this diameter range do not support photonic modes. Emission is seen to be at longer wavelengths compared to bulk GaAs as they originate from the InGaAs QDs. The microscope image of the NW emission also shows emission coming from the entire length of the NW, and is generally weak. In contrast, NWs dispersed on the silver thin film exhibit clear Fabry-Perot peaks, as shown in Fig. 1c. The microscopy image shows strong emission coming from the end facets of the NW, indicative of coupling of the QD emission into the plasmonic Fabry-Perot modes supported by the NW.

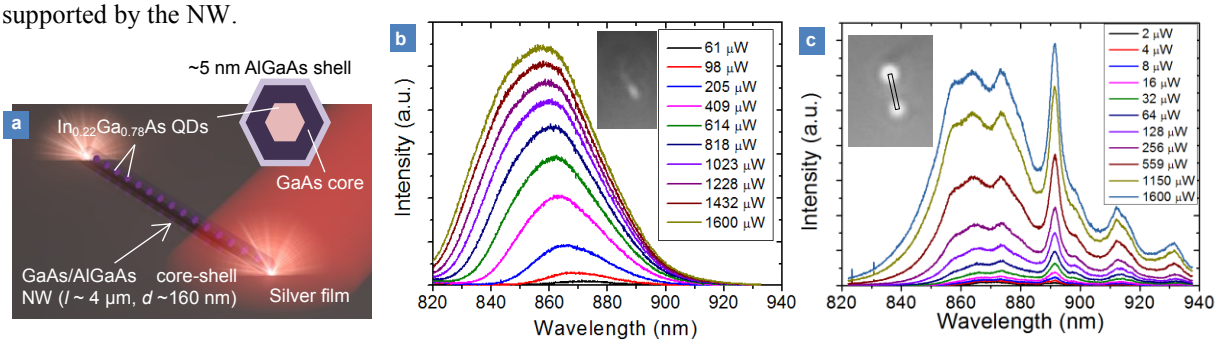

Figure 1. (a) Schematic of multi-stacked InGaAs/GaAs QD in nanowire, placed on a silver film. Inset shows the cross-section of the NW at the location of a QD. (b), (c): Typical power-dependent spectra for nanowires dispersed on SiO_2 (b) and silver (c). Insets show microscope images of nanowire emission.

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References

[1] J. Ho *et al.*, *ACS Photonics* 10.1021/ph5003945 (2014). [2] J. Tatebayashi *et al.*, *75th JSAP Autumn Meeting* 18a-A6-4 (2014).