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銀薄膜上 GaAs ナノワイヤにおける表面プラズモンポラリトンのファブリ・ペローモードの観測

Observation of Fabry Perot Modes of Surface Plasmon Polaritons in GaAs Nanowires on a Silver Thin Film

東大ナノ量子機構[1], 東大生産研[2], °J. F. Ho[1], 館林潤[1],S. Sergent[1], C.F. Fong[1], 岩本敏[1,2], 荒川泰彦[1,2]

NanoQuine[1], IIS[2], Univ. of Tokyo, °J. F. Ho[1], J. Tatebayashi[1], S. Sergent[1], C.F. Fong[1], S. Iwamoto[1,2], Y. Arakawa[1,2]

E-mail: jinfaho@iis.u-tokyo.ac.jp

Nanowires (NWs) represent the 1-dimensional limit of conventional laser cavities, but the diffraction limit prohibits the scaling of NW lasers to subwavelength dimensions. To solve this, NW lasers supporting a hybridized surface plasmon polariton (SPP)-waveguide mode confined in a dielectric spacer layer between the nanowire and a metal film have been demonstrated [1]. However, such lasers have been realized only at 490-520 nm, far from the telecommunications wavelength of 1550 nm, and are thus not suitable for integration with electronics. By incorporating quantum dots in a GaAs NW, SPP NW lasers in the telecommunications wavelengths can be achieved. However, SPP Fabry-Perot modes required for lasing feedback has not been observed for GaAs NWs. In this presentation, we report the first experimental observation of SPP Fabry-Perot modes in GaAs NWs of 160 nm width dispersed on silver.

MOCVD grown AlGaAs/GaAs core-shell NWs with an average diameter of 160 nm and length of 2.9 μm were dispersed on a smooth silver surface (Fig 1a, b). A control sample was also fabricated with nanowires dispersed on a 100 nm SiO_2 layer deposited on Si (111). Photoluminescence measurements were performed at 10 K on both samples (Fig 1c). Only bulk emission from GaAs was observed for NWs on SiO_2 as no optical modes exist below the diffraction limit. In contrast, Fabry-Perot modes arising from SPP modes were observed for NWs on silver. The mode spacing for this sample was 14 nm, which is a good agreement with a theoretically calculated spacing of 12.5 nm. In addition, the Q factor for the peak at 800 nm, defined by $Q = \Delta\lambda/\lambda$, can reach up to 630 at high excitation powers. This is high for SPP structures and can be improved with longer wires, suggesting a possible route for SPP lasing with these structures.

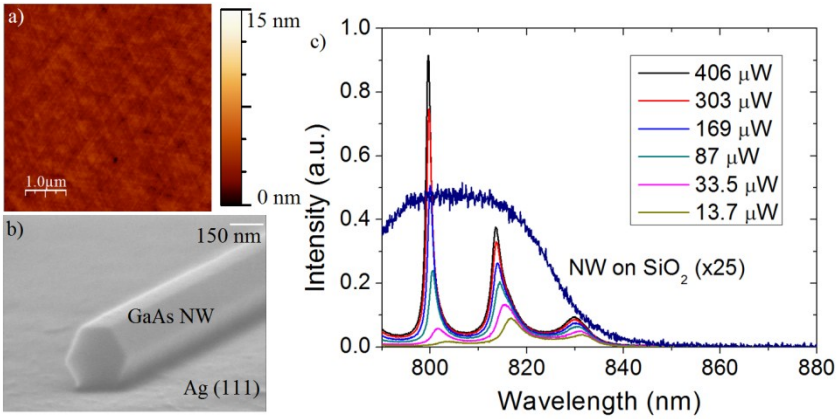

Figure 1. (a) AFM image of silver (111) film, with RMS = 0.48 nm, (b) SEM image of NW on silver film, (c) Emission spectra of NW on SiO_2 at 400 μW (blue, magnified 25x) and power dependent spectra for NW on silver. The spectra were obtained at 10 K with pulsed excitation (λ = 785 nm).

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References

[1] Y. –J. Lu *et al.*, *Science* **337**, 450-453 (2012).