19p-C3-10

Cathodoluminescence of 2D plasmonic crystals with hexagonal lattice

Tokyo Institute of Tech.[1], JST-CREST[2], °Hikaru Saito[1], Naoki Yamamoto[1,2]

E-mail: hsaito@surface.phys.titech.ac.jp

Manipulating light with subwavelength confinement is a critical challenge for nanoscale optical applications. One of the most promising solutions is nanophotonics based on surface plasmon-polartons (SPPs). Metal surfaces with periodic structures called plasmonic crystals (PlCs) enable us to engineer the band structure of SPP, leading to the control of emission and waveguide. Especially, the properties of the band gaps and the band edge states are important for the plasmonic devices, such as chemical sensors, solar cells and lasers. We report systematic experimental studies of the band gaps and the band edge states in two-dimensional (2D) PlCs with hexagonal lattice by using cathodoluminescence (CL) [1].

2D-hexagonal lattices with various pillar (or hole) diameters (D) and a fixed period (P) were patterned on a substrate by electron beam lithography and silver was thermally deposited on them. The present CL measurement was performed in a scanning transmission microscope (STEM) system. The probe size of the electron beam is typically in the order of 1 nm. Figure 1(a) shows the schematic diagram of the experiment. SPPs excited by high energy electrons are converted to photons due to the periodic structures. Light emitted from PlCs is collected by a parabolic mirror, and the emission angle is resolved by a mask. Figure 1(b) shows a typical angle-resolved spectral (ARS) pattern which directly visualizes a band structure. Four kinds of band edge states with different energies are observed at the Γ point. In order to identify the band edge states, we obtained the spectral images (photon maps) of the band edge states (Figure 2(a)-(d)). The intensity distributions of the photon maps are related to the charge distributions of the SPP standing waves, which determine the modes of the band edge states. We studied the dependence of the band gaps and the band edge states on the D/P ratio. This work was supported by MEXT Nanotechnology platform.

[1] H. Watanabe, M. Honda, and N. Yamamoto, *Opt. Express* **22** (2014) p.5155.

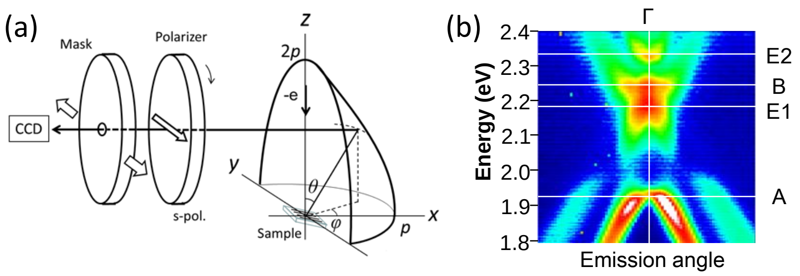

Figure 1: (a) Arrangement of the ARS measurement. (b) A typical ARS pattern.

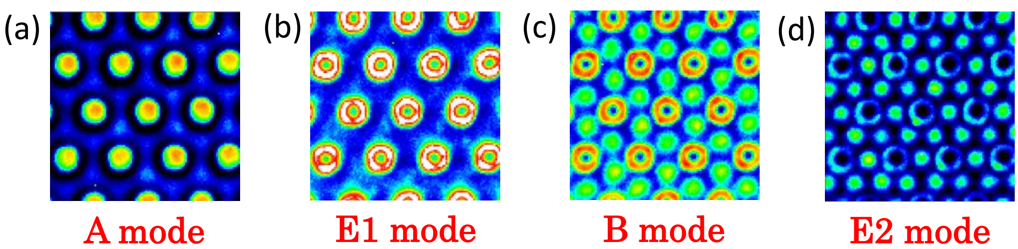

Figure 2: Photon maps of the band edge states.

© 2014 年　応用物理学会