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誘電体フォトニック結晶共振器･ナノ金属構造結合系における様々な相互作用の検討（Ⅲ）

Investigation of electromagnetic interactions in a composite system of a dielectric photonic-crystal nanocavity and a metallic nanostructure (Ⅲ)

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[Introduction] We have studied dielectric-metal hybrid systems consisting of a photonic crystal nanocavity (PCC) and metallic meta-atoms, where both electric and magnetic components of light can be controlled in sub-wavelength range. Recently, it is demonstrated that a PCC and a split ring resonator (SRR)interact through magnetic dipole, and a PCC and metal BAR interact through electric dipole [1-2].In this work, we demonstrate that polarization of the light emitted from PCC can be controlled into circular polarization by utilizing sub-wavelength interaction with a SRR and a BAR simultaneously.

[Structure and Results] Figure 1 shows the two hybrid systems investigated, each of which consists of a L3 type PCC, a metallic BAR, and a SRR. In both systems, BAR is placed at the electric antinode position of PCC, and SRR is placed at the magnetic antinode position of PCC. We chose the design parameters of meta-atoms(BAR:$\ell_1 = 280$nm, SRR:$\ell_2 = 220$nm), so that their resonant wavelengths are positively and negatively detuned from that of PCC by about HWHM of meta-atoms. Therefore, when excited by the light which is on-resonant to PCC, the phase of BAR and SRR shows $\mp\pi/4$ difference with the excitation light. The light emitted from both meta-atoms, which are placed within the wavelength from PCC, are expected to be superimposed to exhibit circular polarization. The calculated snapshots of the near-field electric field distributions and polarizations of radiation at three different timings are shown in Fig.2. It is seen in the figure that the excitation of BAR (t_a) has π/2-phase lead compared with that of SRR (t_c).The polarizations of radiation at individual timings are shown in the insets. Due to the difference of rotation angle of SRR, structure A shows RHC (Right-Hand Circular) polarization while structure B shows LHC (Left-Hand Circular) polarization. Such nano-scale RHC, LHC implementation would be promising for micro-bio sensing to distinguish optical chirality. Other polarization states can be also implemented by expanding this method. Further details will be discussed at the conference.**[Ref.]**[1] 李他、秋季応物 31a-ZR-7(2011),[2] 李他、秋季応物 13a-PA5-1 (2012)

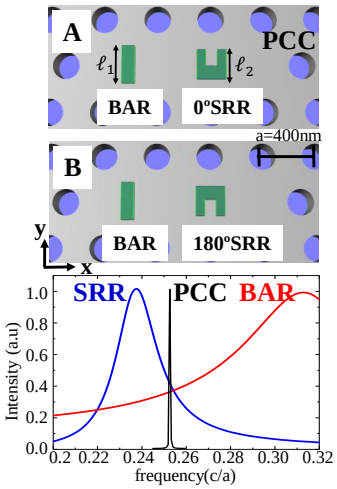

Fig.1. Configuration of each hybrid system, labeled A has BAR+0°SRR, labeled B has BAR+180°SRR, and resonance spectrum of each cavity element; SRR and BAR resonances are detuned from that of PCC.

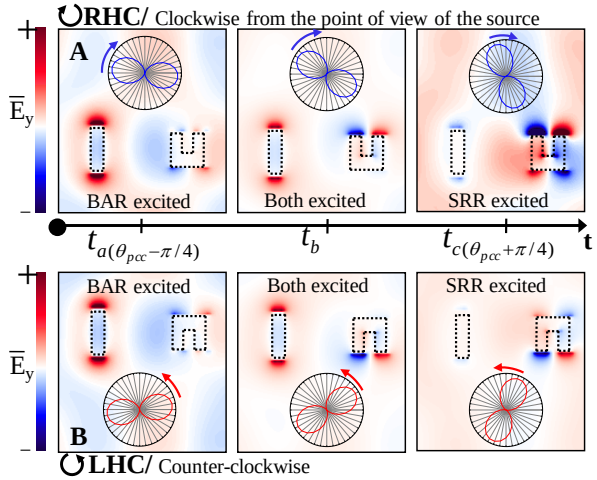

Fig.2. Calculated near-fields (E_y) including radial polarization at certain time steps(t_a,t_b,t_c); Extracted field component from each excited meta-atoms have radiation delay while spinning in RHC (Labeled A)and LHC (Labeled B) direction.