Rabi splitting in CuCl microcavity with DBR consisting of $PbCl_2$/NaF multilayers

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CuCl microcavity realise the giant Rabi splitting energy, therefore it is good candidate for research of cavity polariton. However, the obtained Rabi splitting energy has not been explained exactly in theory [1]. In this report, we show the origin of this discrepancy from the precise investigation for Rabi splitting by comparing the experiment with the theory.

In the experiment, we adopted the new components of $PbCl_2$ and NaF as the distributed Bragg reflectors (DBR). Because of the high contrast of refractive indices of these two dielectric materials ($PbCl_2$: 2.3, NaF: 1.3), our new cavity achieved the quality (Q) factor of about 250. We fabricated microcavities by the vacuum deposition method in the consistent process. The microcavity structure is constituted of a CuCl active layer with the length of half-integer multiple of Z_3 exciton wavelength (λ_{ex}). From the angle resolved reflectance spectra, we observed three polariton branches for cavity polariton consists of Z_3 and $Z_{1,2}$ exciton and cavity photon, and achieved to be Rabi splitting energy : 110 meV (Z_3 exciton) and 195 meV ($Z_{1,2}$ exciton) for λ-cavity (Fig. 1), which is much larger than the previous results [1].

To analyze precisely, the optical response was calculated by nonlocal theory considering spatial structure of exciton wavefunction with center-of-mass quantization [2]. Furthermore, the detailed profiles of refractive indices of $PbCl_2$ and NaF thin films are obtained by spectroscopic ellipsometry. From the precise calculation, the result of reflectance spectra definitely shows all polaritonic structures of the experimental spectra (Fig. 2). Furthermore, Rabi splitting energies obtained from calculation also agree with the experimental results of the various active layer

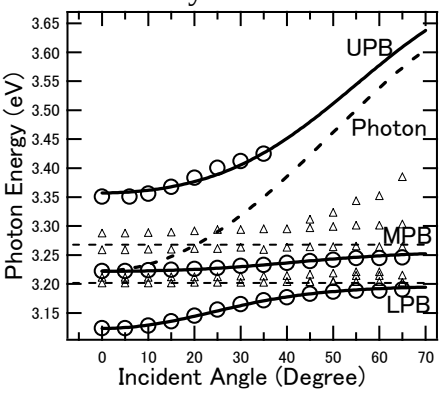

Fig. 1: Dispersion of cavity polariton for λ-cavity. The circles and the triangles are obtained from dips for each angle resolved reflectance spectra. The solid lines indicate calculated eigen energy for three polariton branches.

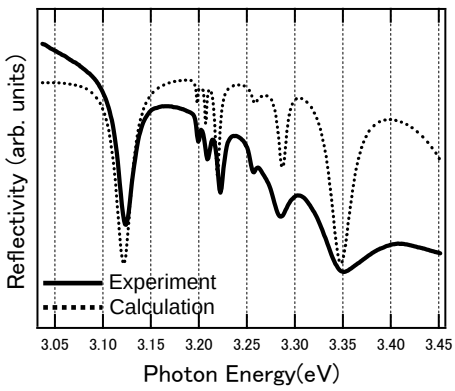

Fig. 2: Experimental (solid line) and Calculation (doted line) results of reflectance spectra at 0° for λ-cavity.

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Reference

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