Optical cavity-mediated exciton dynamics and excitation energy transfer in photosynthetic light harvesting 2 complexes

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Strong light-matter interaction leads to the formation of hybrid polariton states and alters the photophysical dynamics of organic materials and biological systems without modifying their chemical structure. Here, we experimentally investigated a well-known photosynthetic protein, light harvesting 2 complexes (LH2) from purple bacteria under strong coupling with the light mode of a Fabry-Perot optical microcavity. Using femtosecond pump probe spectroscopy, we analysed the polariton dynamics of the strongly coupled system and observed a significant prolongation of the excited state lifetime compared with the bare exciton, which can be explained in terms of the exciton reservoir model [1]. Furthermore, the excitation energy transfer between LH2s was investigated by analysing the exciton-exciton annihilation (EEA) process via intensity-dependent pump probe measurements. and an enhanced EEA was uncovered in the strongly coupled system compared with the bare LH2 film, indicating an enhanced excitation energy transfer between LH2s by the strong coupling. When reducing the coupling strength to weak coupling regime, an enhanced EEA, as well as an enhanced excitation energy transfer process, was also observed. Our findings indicate the potential of tuning the dynamic of the whole photosynthetic unit, which contains several light harvesting complexes and reaction centres, with the help of exciton-photon coupling, and opening the discussion about possible design strategies of artificial photosynthetic devices.

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References

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