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Enhancement of UC Quantum Yield by Combining Metal-Organic Frameworks (MOFs) and Localized Surface Plasmon Resonance (LSPR)

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The triplet-triplet annihilation upconversion (TTA-UC) phenomenon holds great potential for various applications, as it not only converts long-wavelength light into shorter wavelengths but can also be driven by low photon density light, such as sunlight. For practical implementation, achieving TTA-UC in a solid-state system with high stability is desirable. However, performance degradation is inevitable due to the loss of molecular diffusion in solid-state environments. To address this, a method utilizing exciton diffusion instead of molecular diffusion has been explored. This approach employs metal-organic frameworks (MOFs), which prevent the molecular aggregation that would otherwise hinder exciton diffusion, while also allowing dense molecular accumulation, creating a structure that enables the development of high-performance systems.

However, during MOF synthesis, structural defects have been observed, leading to the trapping and deactivation of excitons nearby, which significantly reduces the fluorescence quantum yield. To mitigate this issue, we explored the use of localized surface plasmon resonance (LSPR) with metal nanoparticles. The integration of metal nanoparticles with molecules is known to reduce fluorescence lifetime due to the enhancement of electric fields, a phenomenon known as the Purcell effect. This effect improves the fluorescence quantum yield of MOFs and could potentially result in high TTA-UC quantum yields even in solid-state systems.

Biography:

I am currently a second-year master's student in a laboratory at Nihon University. I am interested in self-assembling materials such as MOFs. I am also interested in the LSPR phenomenon of metallic nanoparticles. I would also like to investigate structures that generate strong electric fields, which is necessary for my research. I am also interested in measuring instruments that can measure nano size particles, since I am currently studying nanoscale particles.