Visible-to-UV Photon Upconversion in Nanostructured Chromophoric Ionic Liquids

Invited for this month’s cover picture is the group of Professor Nobuhiro Yanai and Nobuo Kimizuka at Kyushu University. The cover picture shows visible-to-ultraviolet (vis-to-UV) triplet-triplet annihilation-based photon upconversion (TTA-UC) via triplet exciton diffusion in a chromophoric ionic liquid (IL). Chromophore moieties spontaneously form continuous arrays in non-polar nano-domains of the IL. The close arrangement of the chromophores in the IL allowed effective diffusion of triplet excitons, resulting in the vis-to-UV TTA-UC at a low excitation intensity. Read the full text of their Communication at 10.1002/open.201900304.

What is the most significant result of this study?
Visible-to-ultraviolet (vis-to-UV) triplet-triplet annihilation-based photon upconversion (TTA-UC) in an ionic liquid (IL) is achieved for the first time. Furthermore, we demonstrate that the IL system works under lower excitation light intensity compared to the conventional molecular diffusion-based solution systems. The concert of long triplet lifetime, high absorption coefficient, and fast triplet exciton diffusion in the IL state realized the high-performance solvent-free vis-to-UV TTA-UC system.

What prompted you to investigate this topic/problem?
Liquids are usually considered simply as disordered materials, but recent studies unveiled the formation of unique bicontinuous nanostructures in ILs. Inspired by such interesting IL nanostructures, we have controlled the assembly of chromophores in the non-polar domains of the ILs. In this work, we extend our strategy to vis-to-UV TTA-UC, relevant to photocatalytic applications.

What are the main challenges in the broad area of your research?
One of the biggest challenges is to functionalize segregated nanostructures in ILs with the view of energy conversion and exciton diffusion. We have investigated the relationship between the nanostructural features and the functions of ILs composed of π-conjugated moieties. The future direction would include controlling the arrangement of a wide variety of functional groups in IL nanostructures for desired functions.

What was the inspiration for this cover design?
The fluidic nature and the momentary static feature coexist in the ILs, as depicted in this cover design. An homage to Sunrise by Monet is adopted into the composition of this cover art, wishing this research would illuminate future studies in the field of photochemistry, supramolecular chemistry, and materials science.