Materials for Photon Energy Storage: A New Challenge of Organic Charge Transfer Salts

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Light is a necessity of life. However, unlike electricity, light cannot be stored in a material for weeks or longer, mainly because the energies of light are usually too high to store in substances without inducing decomposition. If light can be stored in materials as batteries store electricity and carried for later use at any time and place, light would be a transportable variable energy source to innovate our lifestyles including emergency scenarios. Here we report new prototype materials that store a part of photon energy for a long time. The crystalline charge-transfer (CT) salts of a flexible coordinate gold-complex with photoreactive aromatic amines, Cat[Au(dmit)$_2$]$_2$ (Cat = BPY[1] or MV[2], BPY = *N,N'*-ethylene-2,2'-bipyridyl, MV = methyl viologen, dmit = 1,3-dithiole-2-thione-4,5-dithiolate: Fig. 1), are unique in their molecular structures: they both contain non-planar (NP) coordinated Au atoms as disorder at the planar coordinated Au sites. Upon UV-irradiation, the NP Au atoms reversibly increased in number or in the distance from the molecular planes in both salts, which were stabilized by the CT interactions between neighboring molecules. Real-time electron spin resonance and X-ray structural analyses during the relaxation after UV irradiation revealed long-lived coherent phonons in the MV salt, which lasted for 7.5 months at ambient temperature. The theoretical calculations of the energies of the observed transient structure demonstrated that the photon energies were partly distributed and exchanged between various coherent phonon modes nearly as standing waves in the crystalline state. If the MV salt can be induced to emit light afterwards in a controlled manner, then photons (as light or other types of energy) may be freely stored, transported, and used just like electricity by mobile batteries. The luminescence properties of the MV salt are now under investigation.

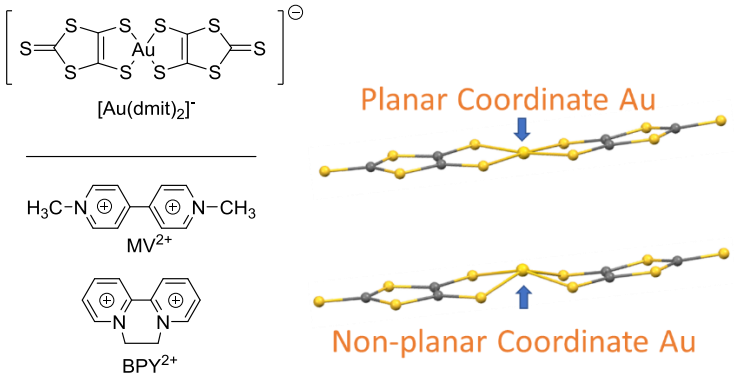

Fig. 1. Molecular structures of Cat[Au(dmit)$_2$]$_2$ (Cat = BPY, MV).

References

[1] T. Naito *et al.*, *Dalton Transactions* **48**, 12858 (2019); K. Ichiryu *et al.*, *Chem. Lett.* **49**, 1038 (2020).
[2] T. Naito *et al.*, *manuscript in preparation*.