Role of chirality in functional properties of self-assembly systems

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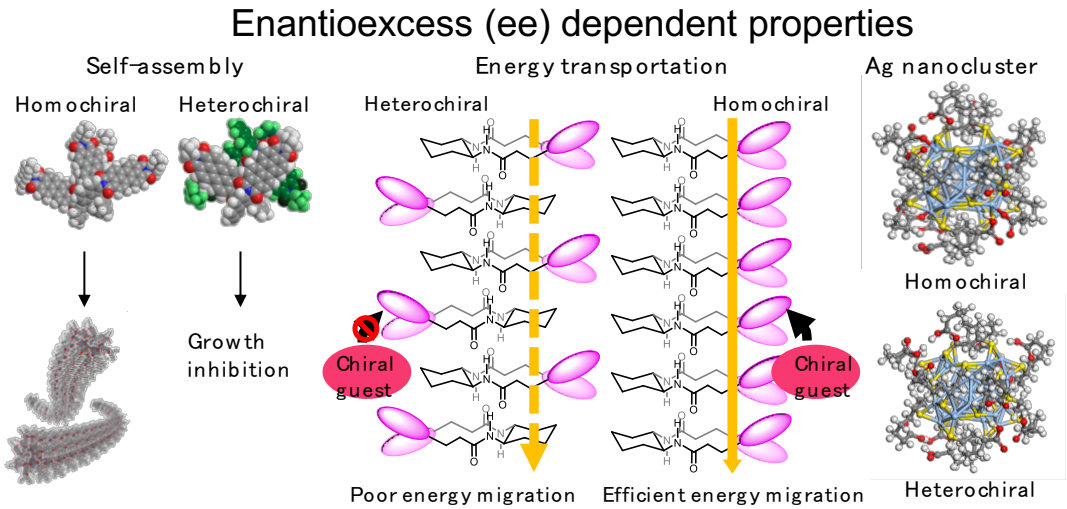
Biological systems have a high level of structural complexity with homochiral nature and work in a synchronized manner to exhibit efficient and rigorous functionalities. Although the advantages have not been clear in nature, the importance of chirality in chemistry is obvious because biological systems, that artificial ones challenge to emulate, are composed of homochiral building blocks. We explored how the chirality play a role in self-assembling systems through a simple approach with modulating the optical purity of components. The subjects include supramolecular polymerization, light harvesting property and emission in chiral metal nanoclusters.

The first example is controlled supramolecular polymerization, in which homochiral bindings drive the 1D assembly while the presence of heterochiral binding inhibit the growth of supramolecular polymer.[1] The length of supramolecular polymers was modulated by the enantiopurity of components. The chirality also has an effect on the energy migration property in the chromophoric self-assembly. The chromophoric compound formed nanofibers regardless of the enanitopurity, while their chiral sensing capability[2] as well as energy transport property were highly dependent on the enantiocompositions.[3] The more enantiopure nanofibers afforded the chromophoric arrangement more suitable for the energy transportation. The final example is the emission property of chiral Ag nanocluster.[4] The emission efficiency of Ag nanocluster increased with increasing the enantioexcess of chiral surface ligand. The one-handed chiral orientation of homochiral surface ligands is considered to effectively stabilize the surface of nanocluster.

The series of experiments demonstrated that the homochiral systems exhibit better performance over nonenantiopure ones. A fundamental symmetry property of chiral molecules comes into operation upon self-assembly in which one chiral object interacts with another chiral object. The homochiral systems demonstrated in the present study allowed the molecular orientations/arrangements suitable for exerting best performances in their functions.



References Refs. [1] J. Kumar et al., *Angew. Chem. Int. Ed.* **2015**, 54, 5943; [2] R. Sethy et al., *Angew. Chem. Int. Ed.* **2017**, 56, 15053; [3] R. Sethy et al., *J. Phys. Chem. Lett.* **2018**, 9, 2151; [4] J. Kumar et al., *Chem. Commun.* **2017**, 53, 1269.