Supramolecular Engineering of Functional Nanosystems

Frank Würthner

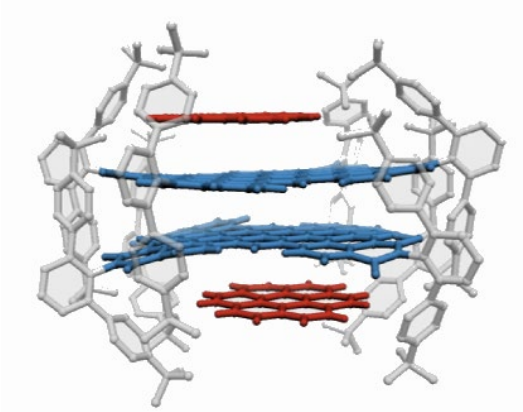
Center for Nanosystems Chemistry & Institut für Organische Chemie, Universität Würzburg,

97074 Würzburg, Germany

E-mail: wuerthner@uni-wuerzburg.de

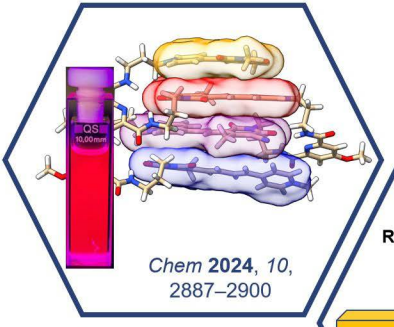
Natural photosystems showcase the importance of supramolecular organization for advanced functional properties. Nevertheless, the development of molecular materials is still mostly initiated by purely molecular considerations whilst the influence of intermolecular couplings is only addressed at a later stage.

For a period of more than twenty years our group has explored an alternative approach. Thus, we have studied the formation of molecular aggregates and the functional properties originating from the interaction of π-systems in terms of structure-function relationships. In this lecture I will showcase examples from our most recent research on perylene bisimide (PBI) dyes[1] as well as smaller and larger polycyclic aromatic (multi-)imides for which we could accomplish structurally well-characterized supramolecular aggregate structures[2] and obtain insight into their photofunctional properties. With the advancement of our knowledge, most recently also tailored supramolecular environments are utilized for the engineering of desired functional properties in molecular aggregates which includes (circularly polarized) fluorescence, phosphorescence and thermally activated delayed fluorescence.[3] Finally, a most recent example of supramolecular engineering based on a porous nanographene bilayer will be discussed.[4]

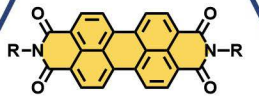


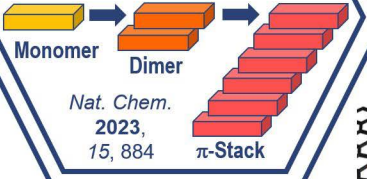
References

[1] R. K. Dubey, F. Würthner, *Nat. Chem.* **2023**, *15*, 884: Playing Lego with perylene dyes.
[2] M. Mahl, M. A. Niyas, K. Shoyama, F. Würthner, *Nat. Chem.* **2022**, *14*, 457: Multilayer stacks of polycyclic aromatic hydrocarbons.
[3] J. Rühe, K. Vinod, H. Hoh, K. Shoyama, M. Hariharan, F. Würthner, *J. Am. Chem. Soc.* **2024**, *146*, 28222: Guest-Mediated Modulation of Photophysical Pathways in a Coronene Bisimide Cyclophane.
[4] M. A. Niyas, K. Shoyama, M. Grüne, F. Würthner, *Nature* **2025**, *637*, 854: Bilayer nanographene reveals halide permeation through a benzene hole.

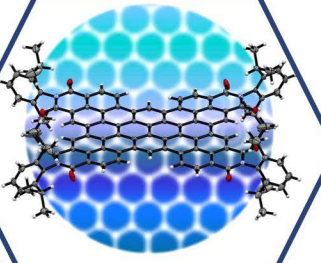


Chem **2024**, *10*, 2887–2900

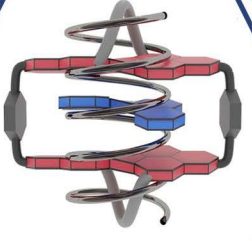




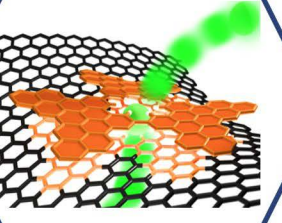
Nat. Chem. **2023**, *15*, 884



Nat. Chem. **2022**, *14*, 457



Angew. Chem. Int. Ed. **2023**, e202301301



Nature **2025**, *637* 854