

Supramolecular Chemistry Laboratory



HEAD:

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RESEARCH PROFILE:

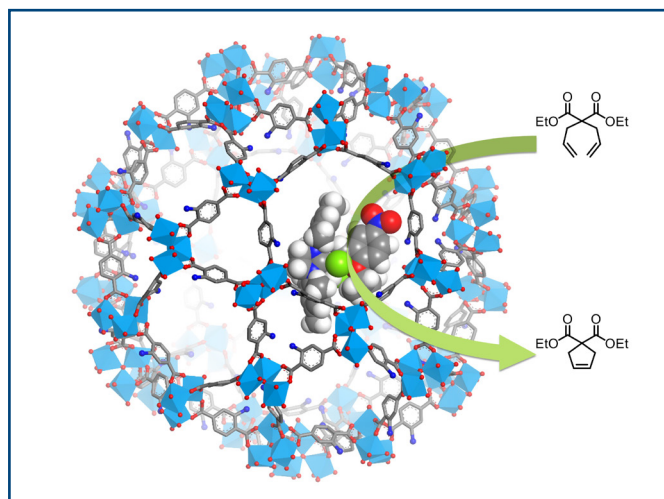
1. metal-organic frameworks (MOFs)
2. supramolecular chemistry of anions

CURRENT RESEARCH ACTIVITIES:

Supramolecular chemistry – 'chemistry beyond molecule' – is an interdisciplinary field of research focusing mainly on self-organisation of molecules into well-defined chemical structures by reversible intermolecular interactions, such as coordination and hydrogen bonds, pi-stacking and others.

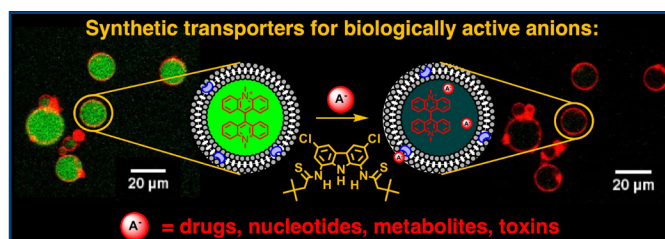
Our core specialties are 1) metal-organic frameworks and 2) supramolecular chemistry of anions.

Metal-organic frameworks (MOFs) are crystalline coordination compounds with regular arrays of nanoscopic voids (such as cavities, channels, etc.) in their crystal structures. The porosities and functionalities of MOFs can be easily fine-tuned for multiple applications, such as gas storage (especially H₂, CH₄, and CO₂), separation processes, drug delivery, ion exchange, sensor technology, non-linear optics, magnetism, luminescence, and many others. We are particularly interested in developing conducting MOFs (in collaboration with researchers from MIT) for a wide variety of applications, including fuel cells, batteries, supercapacitors, catalysts, sensors, thermoelectrics, etc. In another line of research, we are also interested in catalytic processes inside the nanoscopic voids of MOFs. Our recent accomplishments in this field include the first successful immobilisation of olefin metathesis catalysts inside MOFs (in collaboration with the group of prof. K. Grela), the first incorporation of enantioselective hydrogenation catalysts into MOFs as well as the development of exquisite MOF catalysts for aerobic oxidation of alcohols to aldehydes.



On the other hand, the development of molecules that are able to strongly and selectively bind anionic species is also of great importance in various fields, due to a range of important roles anions play in many chemical, biological, medicinal and environmental processes. Such molecules (receptors) could be useful as sensors and transporters able to facilitate anion transport through biological membranes. We also exploit anions as templates for the construction of complex, topologically non-trivial nanostructures, such as catenanes, rotaxanes, helicates, and grids.

For example, we have recently discovered a family of simple, easy-to-make and remarkably active anion transporters. In a major methodological contribution, we have developed the first direct method to study the transport of a variety of biologically relevant anions through lipid bilayers. Using this method, we have discovered the first artificial receptors able to transport amino acids through biological membranes. In another recent project, we have constructed the first photoswitchable ion-pair receptor. This major accomplishment has been published in the prestigious 'Journal of the American Chemical Society'. For the most recent accomplishments, follow our webpage: www.mchmielewski.pl



SELECTED PUBLICATIONS:

1. L. Xie, S.S. Park, M.J. Chmielewski, H. Li, R.A. Kharod, M.G. Campbell, M. Dincă, Isoreticular Linker Substitution in Conductive Metal-Organic Frameworks with Through-Space Transport Pathways, *Angew. Chem. Int. Ed.* 2020, doi.org/10.1002/ange.202004697
2. K.M. Bąk, B. van Kolck, K. Masłowska-Jarżyna, P. Papadopoulou, A. Kros, M.J. Chmielewski, Oxyanion Transport across Lipid Bilayers: Direct Measurements in Large and Giant Unilamellar Vesicles, *Chemical Communications*. 56 (2020) 4910-4913.
3. Z. Kokan, M.J. Chmielewski, A Photoswitchable Heteroditopic Ion-Pair Receptor, *J. Am. Chem. Soc.* 140 (2018) 16010-16014.
4. K. Zwoliński, M.J. Chmielewski, TEMPO-Appended Metal-Organic Frameworks as Highly Active, Selective, and Reusable Catalysts for Mild Aerobic Oxidation of Alcohols, *ACS Appl. Mater. Interfaces*. 9 (2017) 33956-33967.
5. A. Chołuj, N. Nikishkin, M.J. Chmielewski, Facile post-synthetic deamination of MOFs and the synthesis of the missing parent compound of the MIL-101 family, *Chem. Commun.* 53 (2017) 10196-10199.
6. A. Chołuj, A. Zieliński, K. Grela, M.J. Chmielewski, Metathesis@MOF: Simple and Robust Immobilization of Olefin Metathesis Catalysts inside (Al)MIL-101-NH₂, *ACS Catal.* 6 (2016) 6343-6349.

7. K.M. Zwoliński, P. Nowak, M.J. Chmielewski, Towards multifunctional MOFs – transforming a side reaction into a post-synthetic protection/deprotection method, *Chem. Commun.* 51 (2015) 10030-10033.
8. M.J. Chmielewski, E. Buhler, J. Candau, J.-M. Lehn, Multivalency by Self-Assembly – Binding of Concanavalin A to Metallosupramolecular Architectures Decorated with Multiple Carbohydrate Groups, *Chem. Eur. J.* 20 (2014) 6960–6977.
9. K.M. Bąk, M.J. Chmielewski, Sulfate templated assembly of neutral receptors in aqueous DMSO – orthogonal versus biplane structures, *Chem. Commun.* 50 (2014) 1305-1308.
10. A. Brown, K. Mullen, J. Ryu, M. Chmielewski, S. Santos, V. Felix, A. Thompson, J. Warren, S. Pascu, P. Beer, Interlocked Host Anion Recognition by an Indolocarbazole-Containing [2]Rotaxane, *J. Am. Chem. Soc.* 131 (2009) 4937–4952.