MOFs USE IN DRUG SEPARATION, STORAGE AND DELIVERY

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Science fiction as of now, metal-organic frameworks may one day be inside our bodies, carrying drugs in the blood vessels. Also, the use of MOFs to separate organic compounds from others alike appears as an alternative to expensive separation methods used nowadays. Interesting products can be recovered with a high purity, as required in chemical and medical industries.

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A handful of uses for molecular sieves have been found in the second half of the 20th century. Zeolites in particular had helped separating numerous industrial compounds, and are found nowadays as a necessary component in many chemical processes.[1]

Over the last decade there has been an increasing interest in the use of new molecular sieves, which would expand the possibilities of zeolite-like adsorbents. Metal-organic frameworks (MOFs) are porous materials consistent of metallic centers connected by organic linkers, forming a network of cages diverse in size and geometric form. [2]

The vast majority of experimental works using MOFs are focused on separating relatively small molecules. However, some promising uses derived from capturing larger organic molecules are opening a new field of investigation, offering a huge amount of structures that could be modified to store different compounds efficiently.[2]

Apart from many petrochemical industry-derived large molecules, which separation using zeolites and MOFs has been and still is widely studied, health-related compounds are gaining interest. Many of these drugs are found in mixtures with traces of non-interesting molecule. The drugs are thought to be used on humans, so those trace molecules need to be removed, since they could cause some side effects. [3]

MOFs could also be used to obtain high purity drugs from sources that would be treated as invaluable industrial waste.

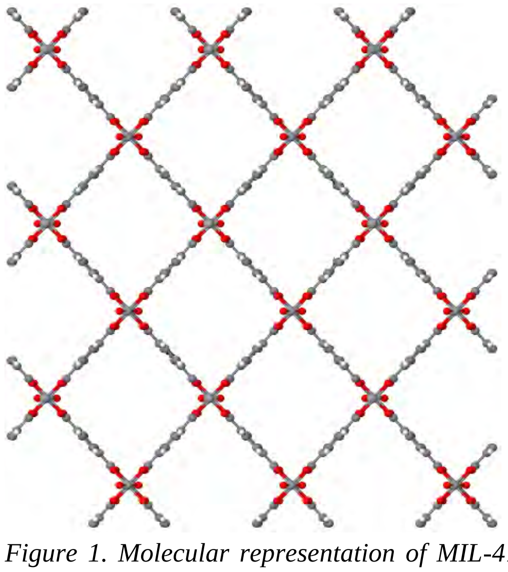

Figure 1. Molecular representation of MIL-47, a MOF with vanadium as metal center. Rhomboid cages are shown. [4]

Utilization of green tea industry wastes to obtain pharmaceutical compounds is an example of revalorizing effluents using MOFs. In this case, tea waste contents relatively high amounts of organic compounds such as caffeine or epigallocatechin gallate (egcg). Caffeine medical applications are well known, and is found in many pharmaceutical products, most of them nervous system stimulants. Egcg is an antioxidant which is gaining some attention in the experimental medicine field, as it promises to be helpful in the treatment of several types of cancer, cardiovascular-related diseases, and HIV infection. [5]

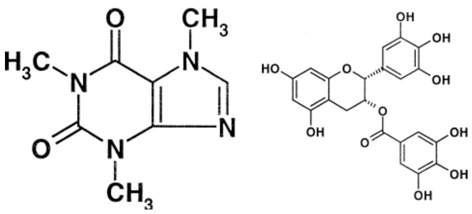

Figure 2. Schematic view of caffeine (right) and epigallocatechin gallate (left) [5]

Recovering egcg from the main mixture is an expensive procedure, due the amount of catechin derivates found there, similar both in physical and chemical properties to egcg. Using MOFs as molecular sieves could be a cheaper response to current procedures, since investigation on the field is currently underway.

The future of MOFs pharmaceutical applications could be far from just recovering and storing molecules. Recent studies are being carried out, looking for structures capable of safely store and deliver drugs inside the organism.

Studies by Sun et al. [6] suggest that modified MOFs could be suitable to use in human treatments because of their organic nature and therefore high biodegradability. Adjustments in the metal core would be needed to avoid possible toxicological issues. Also the organic linkers could be modified; even endogenous organic compounds from the humans could be used instead of traditional ones.

Besides, cell-specific adapters would be required to allow the cell-MOF interaction and ensure the delivery of the drugs to the right place in the organism, process known as controlled release.

Experimental reports for this use of MOFs are still at in vitro stage. Further improvements would be mandatory to pass up to in vivo tests, as stated before, and results would take many years from now to go public and make a difference in the way drugs are stored and released inside the human body.

Maybe one day our blood vessels would carry MOFs sailing away in the blood plasma, up to the right place, at the right time.

Referencias

1. *P. A. Jacobs, E. M. Flanigen. Introduction to Zeolite Science and Practice. 2nd edition, Elsevier Science B.V. (2001) Chapter 2, p 11*

2. *S. L. James.Metal-organic frameworks. Chem. Soc. Rev. Vol 32 pp 276-88 (2003)*

3. *N. Liédana et al. CAF@ZIF: One-Step Encapsulation of Caffeine in MOF. Appl. Mater. Interfaces. Vol 4 pp 5016-21 (2012)*

4 *K. Barthelet et al. A breathing hybrid organic-inorganic solid with very large pores and high magnetic characteristics. Ang. Chem. Int. Ed. Vol 41(2) pp 281-84 (2002)*
Computer model by D. Dubbeldam (2011).
Image obtained using Jmol viewer

5. *J.P. Aucamp et al. Simultaneous analysis of tea catechins, caffeine, gallic acid, theanine and ascorbic acid by micelar electrokinetic capillary chromatography. Journal of Chromatography A. Vol 876 pp 235-42 (2000)*

6. *C. Y. Sun et al. Metal-organic frameworks as potential drug delivery systems. Expert Opin. Drug Deliv. Vol 10(1) pp 89-101 (2013*