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THE ROYAL SWEDISH ACADEMY OF SCIENCES

The Royal Swedish Academy of Sciences has decided to award the Nobel Prize in Chemistry 2025 to **Susumu Kitagawa**, **Richard Robson** and **Omar M. Yaghi** "for the development of metal–organic frameworks".

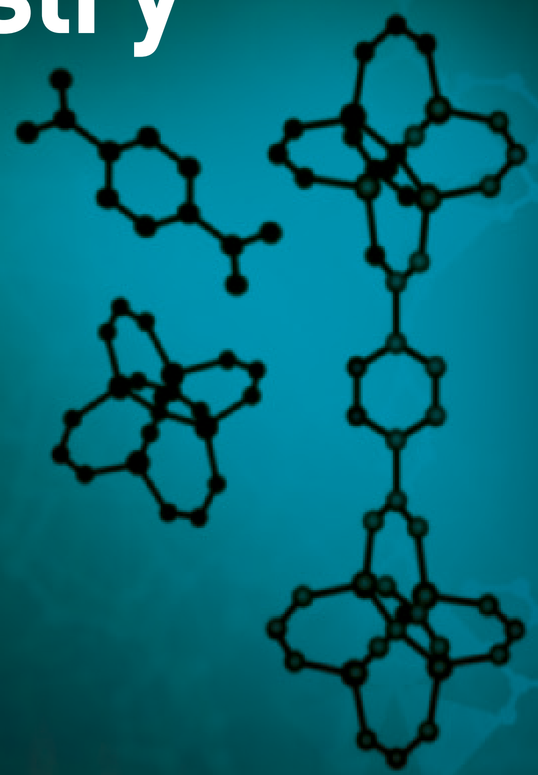
The Nobel Prize 2025 **in Chemistry**

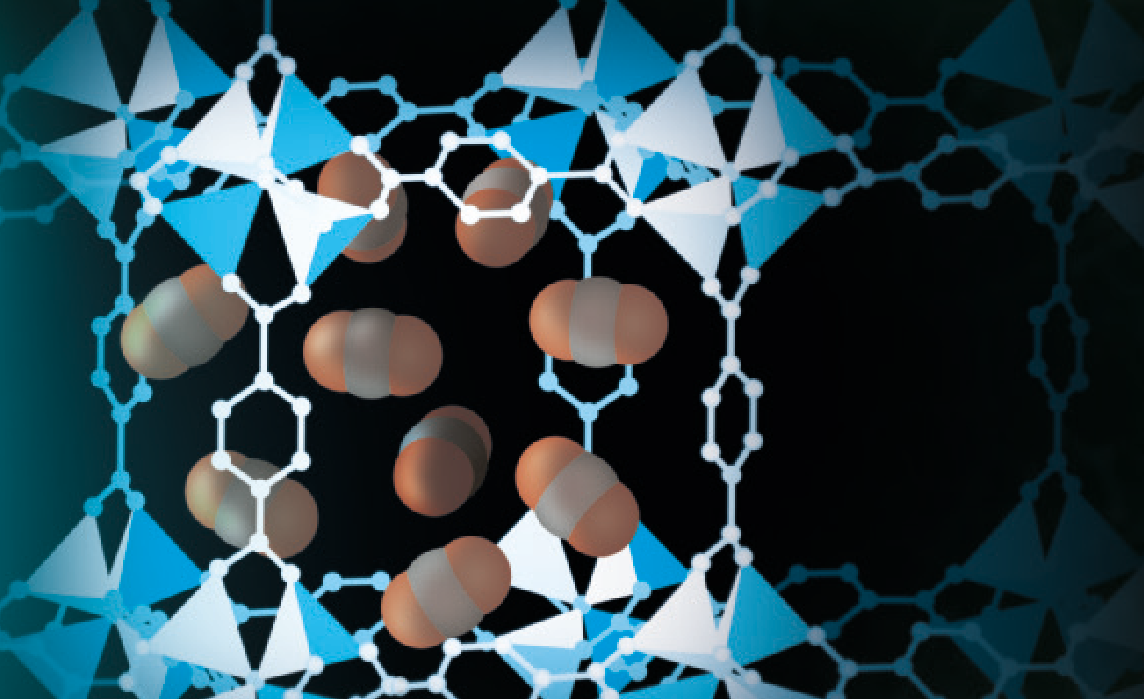
They created new rooms for chemistry

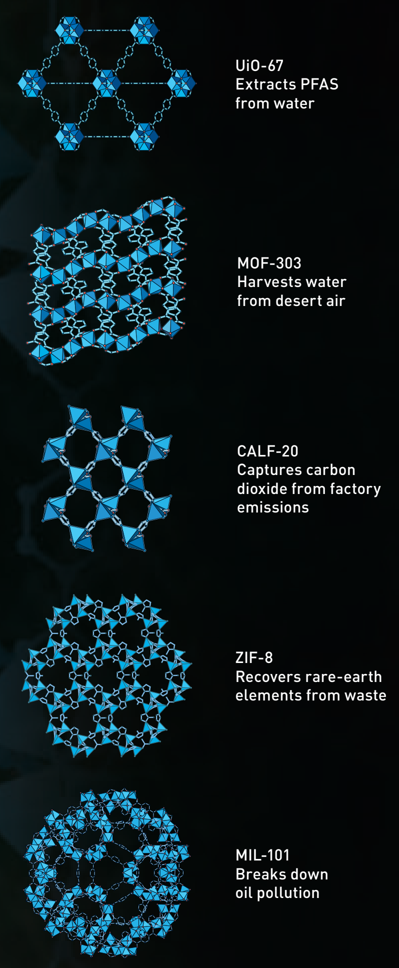
The Nobel Laureates in Chemistry have developed a new form of molecular architecture. Their constructions – which are called *metal–organic frameworks* – contain large cavities in which molecules can move in and out. Researchers have used them to harvest water from desert air, extract pollutants from water, capture carbon dioxide and store hydrogen.

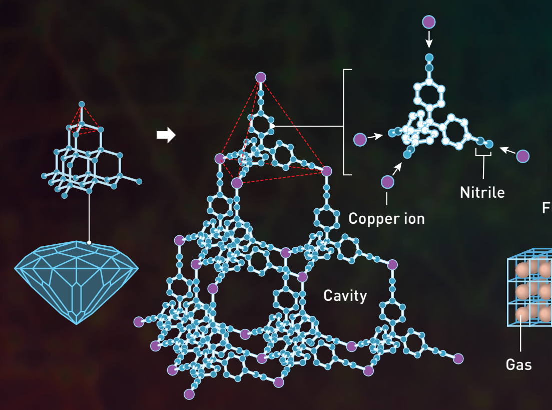
An attractive and very spacious studio apartment, specifically designed for your life as a water molecule – this is how an estate agent might describe one of all the metal–organic frameworks that laboratories around the world have developed in recent decades. Other constructions of this type are specially designed for capturing carbon dioxide, separating PFAS from water, breaking down environmental contaminants, delivering pharmaceuticals in the body or managing extremely toxic gases.

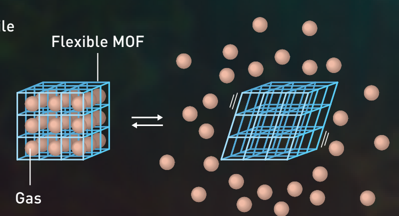
Susumu Kitagawa, **Richard Robson** and **Omar Yaghi** are awarded the Nobel Prize in Chemistry 2025 because they designed metal–organic frameworks (MOFs) and demonstrated their potential. These molecular constructions are built using metal ions – which act as cornerstones – and organic (carbon-based) molecules that link them together. Chemists can tailor MOFs and give them different functions by varying their building blocks.

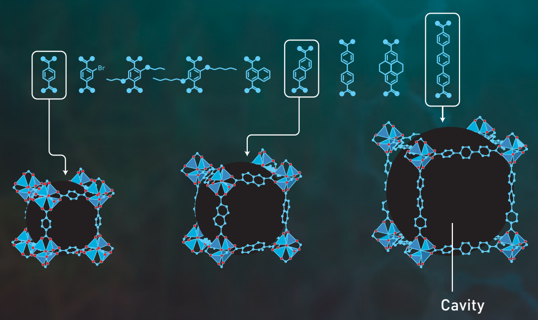












Robson builds innovative chemical structures

In 1989, Richard Robson began to exploit atoms' inherent abilities to form chemical bonds in a new way. He was inspired by the pyramid-like structure of a diamond, but instead of carbon atoms he used copper ions. He combined these with a four-armed molecule that had a chemical group, *nitrile*, which is attracted to copper ions, at the end of each arm. Most chemists of the time would have assumed that this mixture would form a molecular mess, but the ions and molecules organised themselves into an ordered and spacious crystal. It was like a diamond, but filled with a vast number of cavities. Robson had come up with a new way of building materials.

Kitagawa builds hotels for gas molecules

In 1997, Susumu Kitagawa succeeded in building a very stable MOF. It did not collapse, even when he emptied it of all its contents. He demonstrated that its cavities could function as a molecular hotel for gas molecules: methane, nitrogen or oxygen could move in and out, without the material changing.

A year later, Kitagawa predicted that MOFs could form soft materials. They would contain flexible molecular building blocks, allowing the material to change shape. Just a few years later, Kitagawa and other researchers produced soft MOF materials.

Yaghi creates an iconic MOF

Omar Yaghi coined the name "metal–organic framework" in 1995. Four years later, he presented a material that has become iconic: MOF-5. This is an exceptionally spacious, yet stable, molecular construction. Just a few grams of MOF-5 can hold an area the size of a football pitch.

In the early 2000s, Yaghi also showed that rational design can be used to modify MOFs, giving them different properties. This included producing 16 variants of MOF-5, with cavities that were both larger and smaller than those in the original material. His work helped researchers understand how easy it could be to design new MOFs.

MOFs help solve many challenges

Following the laureates' groundbreaking work, metal–organic frameworks have taken the world by storm. There are now tens of thousands of different MOFs, some of which may help us solve some of the challenges humanity is facing. Many have so far only been tested on a small scale, but companies are developing methods to mass produce and commercialise MOFs.

Susumu Kitagawa
Born 1951 in Kyoto, Japan. Professor at Kyoto University, Japan.

Richard Robson
Born 1937 in Glusburn, UK. Professor at University of Melbourne, Australia.

Omar M. Yaghi
Born 1965 in Amman, Jordan. Professor at University of California, Berkeley, USA

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More information about the Nobel Prize in Chemistry 2025 is available at *www.kva.se/nobelchemistry2025* and *www.nobelprize.org*, with video and detailed information about the prize and the laureates.

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