Former ASU assistant professor, now at UC Berkeley, wins Nobel Prize in chemistry

Key discoveries were made at ASU in 1990s

By Joe Caspermeyer, ASU News
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The Royal Swedish Academy of Sciences today awarded the 2025 Nobel Prize in chemistry to former Arizona State University Assistant Professor Omar Yaghi for his breakthrough discoveries that established a new field called reticular chemistry.

“It’s the first time a Nobel Prize in chemistry has been bestowed for truly breakthrough work first performed right here, in the labs at ASU," ASU President Michael Crow said. “This Nobel Prize honor marks an historic, international scientific day of achievement, recognition and pride for ASU.”

Yaghi shared the Nobel Prize with fellow awardees Susumu Kitagawa and Richard Robson for the development of metal-organic frameworks, or MOFs, which contain large, porous holes to store and release all kinds of molecules.

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First reactions: Omar Yaghi, 2025 Nobel Prize in chemistry

“Based on their groundbreaking discoveries, the true excitement is that we, as a society, are now just beginning to see the innovative applications based on their work,” Crow said. “Their successes could pave the way to changing our society from a fossil fuel-driven economy to a hydrogen economy by the more efficient storage of gases, help us harvest more water for a thirsty world or even remove excess carbon from Earth's atmosphere."

Yaghi, now a professor at University of California, Berkeley, made his discoveries by first teaming up with Professor Michael O’ Keeffe at ASU in the 1990s.

They were the first to design and make the most stable series of MOFs at the time. The MOFs Yaghi synthesized with his graduate students in the Goldwater Center building were porous crystals, strongly bonded and stable, with a unique design of atoms that can be arranged in precise geometries to act like molecular sponges.

“This is an extraordinary achievement,” said Professor Neal Woodbury, vice president and chief science and technology officer for ASU’s Knowledge Enterprise. “When I first came to ASU in 1988, I had the privilege of witnessing the ASU team’s discoveries firsthand as they set about their groundbreaking work on the fundamental structure and properties of new molecules and materials. MOFs are exquisitely designed and elegant molecules that, despite their small size, when put together, have remarkable powers and potential to now help mitigate the effects of climate change.”

Part of a homegrown Nobel for ASU

Yaghi, who was an assistant professor at ASU from 1992–98, was a master in chemical synthesis and growing crystals. More than 30 years ago, he and O’Keeffe embarked on a quest to upend the limits of chemistry at the time.

Yaghi was a young, ebullient assistant professor. O’Keeffe, now a 91-year-old professor emeritus who still remains active in his field, spent his entire academic career at ASU.

One day, Yaghi sat down in O’Keeffe’s office in what was then the Department of Chemistry and Biochemistry. The reserved, England-native O'Keeffe asked him if he could synthesize a particularly beautiful, complex crystal in his lab.

Yaghi brashly replied, “Of course!”

And so began the field now known as reticular chemistry.

Yet there were many doubters at the beginning.

O’Keeffe explained: “Those who went to conferences where such materials were discussed three decades ago heard the chorus: 'They won’t be stable.' They were. 'The frameworks will collapse when solvent is removed.' They didn’t. 'They won’t be porous.' They were — they adsorbed gases at low pressures and had 'permanent' porosity."

This porosity — a big opening in the heart of a MOF structure — was typically filled with a placeholder of a yellow balloon (their inspiration was the ASU sun logo at the time) to show the size of a molecule that could fit within the space. These yellow, space-filling balloons became a hallmark of their MOF designs.

The pair had invented a new crystal chemistry of stable and extremely porous MOFs.

And soon, they quickly proved the naysayers wrong, with one structure in particular: MOF-5, which attracted worldwide attention in its ability to hold gases. It earned O’Keeffe, Yaghi, Hailian Li and Mohamed Eddaoudi a publication in Nature*,* and changed everything. This demonstrated to the scientific community that MOFs had truly unprecedented surface area, porosity and stability.

According to the official Nobel announcement, "the material has become a classic in the field. Even when empty, it can be heated to 300 degrees Celsius (572 degrees Fahrenheit) without collapsing." Just a couple of grams of MOF-5 can hold an area as big as a football field, and absorb much more gas.

Watch

Omar Yaghi gives the inaugural O'Keeffe Lecture titled "Reticular Chemistry and Materials for Water Harvesting from Air Anytime Anywhere" at ASU's School of Molecular Sciences on Nov. 19, 2021.

“A chemist can twist around an atom in a molecule from being a poison to a medicine,” said Yaghi in a YouTube video. “It’s that type of control that you want to have on this hidden world to allow you to do beneficial things. MOFs are porous crystals, or porous sponges, and the first wave of applications deals with the storage of gases. There is a lot of interest because MOFs are easy to make, and they can be scaled up to make in multi-ton quantities.”

A generational impact on society

Today, scientists are forming startup companies to explore commercial applications, or trying to incorporate 3D printer manufacturing technologies for MOFs.

Since their first discoveries and landmark Nature publication, Yaghi and O’Keeffe both ranked within the top five most-cited chemists in the world between 2000 and 2010, showing their impact among the scientific community.

In a precursor to Yaghi winning the 2025 Nobel Prize, Yaghi and O’Keeffe were awarded the Aminoff Prize in 2018 from the Royal Swedish Academy of Sciences in recognition of their achievements.

Based on their ingenuity, there are now hundreds of thousands of MOF structures that have been produced, each with a new variation on their classic themes.

For more info on the official announcement, visit the Nobel Prize website.

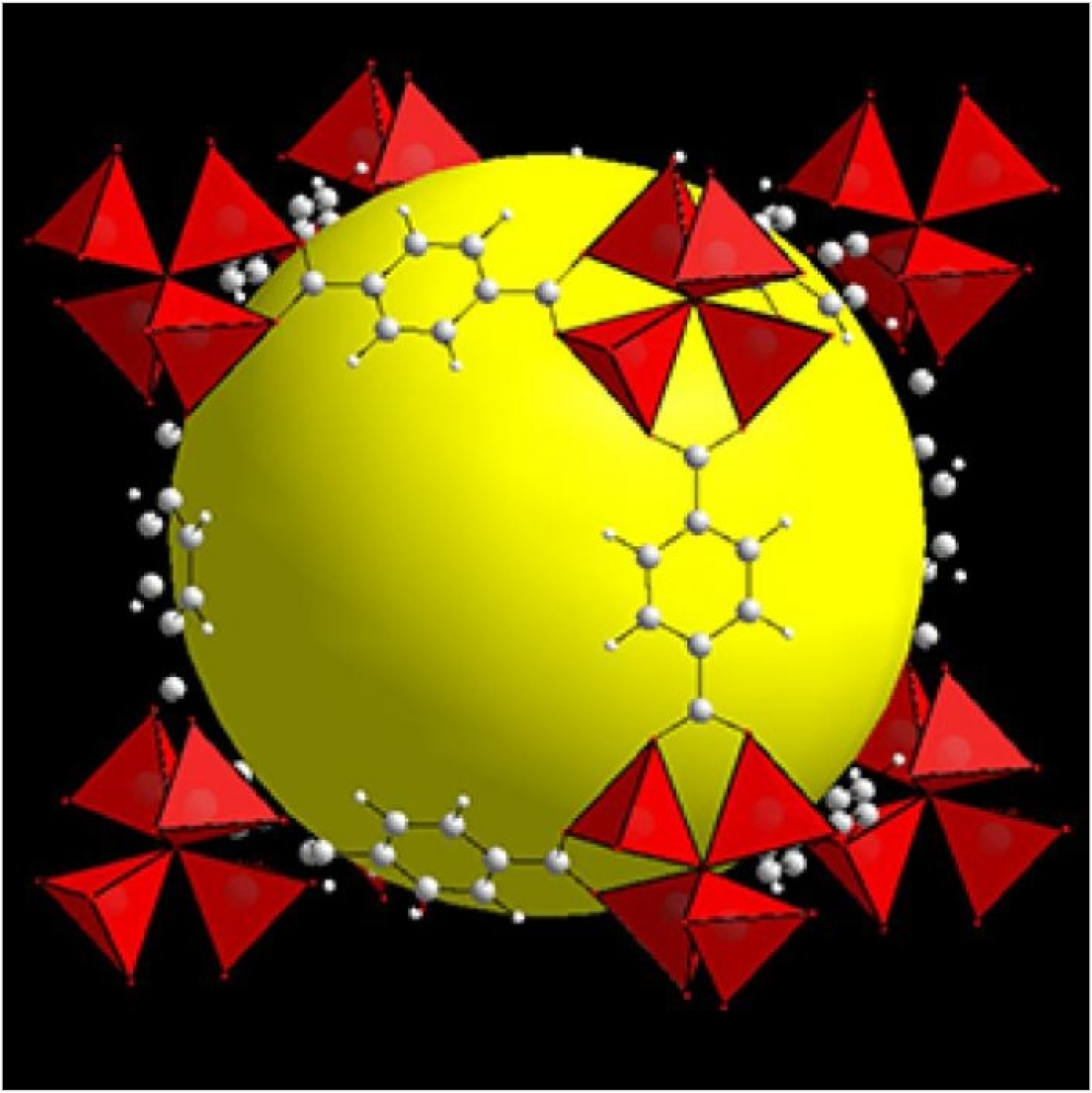
This story originally appeared on ASU News.

Main image

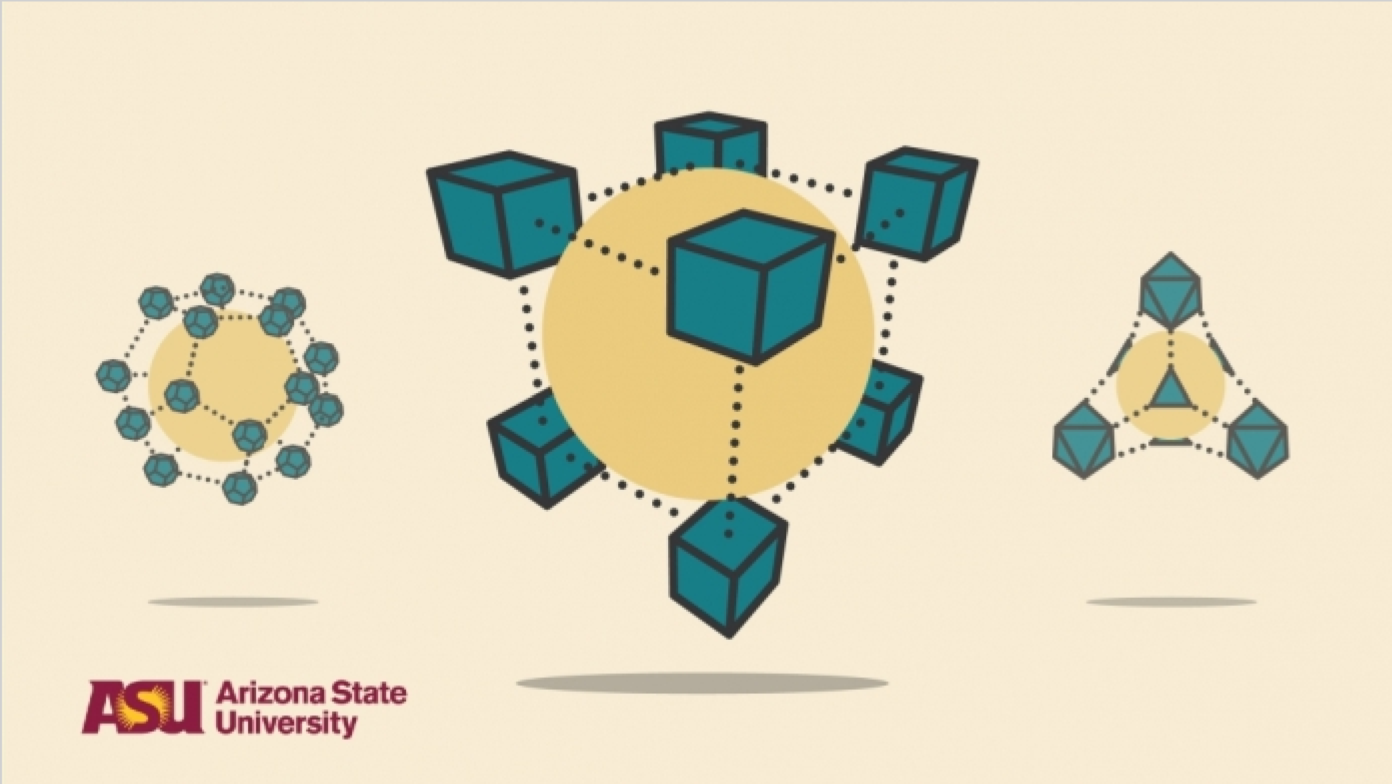
Omar Yaghi, now a professor at University of California, Berkeley, made his discoveries in reticular chemistry by first teaming up with Professor Michael O' Keeffe at ASU in the 1990s. He has been awarded the 2025 Nobel Prize in chemistry for his work. Photo by Samantha Chow/Arizona State University

Text image(s)

ASU Professor Emeritus Michael O’Keeffe and UC Berkeley Professor Omar Yaghi. Photo by Samantha Chow/Arizona State University



O’Keeffe typically filled in his models with a placeholder of a yellow balloon to show the size of a molecule that could fit within the space. Courtesy image



An illustration shows the type of geometries that can be made by metal organic frameworks, or MOFs, which can be made with strong bonds containing atoms of carbon, hydrogen and oxygen combined with metals like zinc for entirely new properties, like storing gases more compactly. Illustration by Alex Cabrera/ASU