RSC Publishing

Publishing

Chemical Technology

Chemical technology news from across RSC Publishing.

Interview: The beauty of molecules

13 July 2009

Omar Yaghi is trying to solve the clean energy problem. Elizabeth Davies investigates

Omar Yaghi is the Jean Stone Professor of Chemistry at the University of California, Los Angeles, US and is ranked among the top 10 most highly cited chemists worldwide. He has received many awards for his work, including the 2009 American Chemical Society Chemistry of Materials Award and the International Izatt-Christensen Award in Macrocyclic Chemistry. He is the inventor of metal-organic frameworks (MOFs), zeolitic imidazolate frameworks (ZIFs) and covalent organic frameworks (COFs).

What inspired you to become a scientist?

I became interested in chemistry as a child after I saw stick and ball drawings of several molecules, such as water and methane. It was attractive because the secret of a material was revealed by knowing the chemical structure. At that time, I felt like I was discovering something that was hidden about these materials. It was a lot of fun. I always wanted to dig deeper to find what was behind the phenomena and that was really my attraction to chemistry. That's not to say I was born to do chemistry or that I was set on chemistry from the outset. I think all that came later once I started doing chemistry.

"It was attractive because the secret of a material was revealed by knowing the chemical structure."

What do you like most about your job?

Two main things keep me motivated. My research is mainly focused on making new materials and so succeeding in making a material, whether it is something you predicted or something unexpected, is very exciting. The other aspect, which I have only really felt as I have become older, is the lasting satisfaction of seeing students grow. They come into the lab very eager to learn but also naïve about various things and sometimes intellectually unprepared. It is exciting to see them grow during graduate school. At the end of their graduate career, they tell me they never realised just how fundamentally graduate school would change their personality. They are more prepared, not just technically, but for whatever challenges that they may face. Their minds have improved and they can think about various solutions to problems, whether they are technical or not.

You have been an instrumental player in the chemistry of MOFs, COFs and ZIFs. Of which achievement are you most proud and why?

We're very passionate about making sure that what we do is new and exciting and I don't really have any single event or result that I am most proud of. Although, in retrospect, the synthesis of MOF-5 was a turning point in MOF chemistry because for the first time we were able to take an inorganic unit and an organic unit and put them together into a pre-determined structure. The synthesis showed new ways of making materials and the properties broke the porosity record, so this was exciting.

The gas storage ability of MOFs has been the focus of much research recently. Where do you see the field in 10 years time?
Already, we are very close to using some of these MOFs in automobile fuelling by natural gas. I think that materials of this kind (MOFs, COFs or ZIFs) are going to be the materials that allow room temperature hydrogen storage. They have already shown exceptional properties in the capture of carbon dioxide. We will also see them used in high value, high performance type applications, such as imaging or drug transport. In the long run, we will see MOFs that are capable of more complex functions. I think, ultimately, and this is something we are aiming for, you will be able to design MOFs that have been modified to produce low-coordinated metals which hopefully we can use to activate carbon dioxide. Instead of capturing carbon dioxide and pumping it underground, we want to be able to convert it into a fuel.

Lots of your work has an impact in the wider media. How important do you think it is to get chemistry this kind of exposure?

"I think it is important for [younger people] to see that chemistry is a field that has important implications in our daily lives."

It's good and bad. It's good for society and younger people who aspire to do something useful in their life to see that chemistry is not some exclusive club. I think it is important for them to see that chemistry is a field that has important implications in our daily lives. So that's the positive side. The negative side is that sometimes the media simplifies things so much that the reader is given the wrong information or impression about various aspects of chemistry. I find the scientific media to be much more careful than the general media. In general, the media attention that some of our results has received has had a lot of positive impact.

What advice would you give to a young scientist who wants to pursue a career in materials chemistry?
This might be highly biased advice, as it's from my own experience, but I think what helped me a lot is that I didn't go into chemistry to solve some big problem. I went into it because I was attracted to how beautiful chemical structures are. That guided a lot of what I did in graduate school and as a post doc. When I became an assistant professor at Arizona State University, I continued to do things that I thought were aesthetically pleasing. After you have made the 50th structure, you start thinking, 'well, what are these good for? Are they just sculptures to look at and admire or could they contribute to solving a societal problem?' Needless to say that the last part of this statement has a lot to do with funding. In those days, the US National Science Foundation and other funding agencies were encouraging people to do research that they called relevant, which means that the materials had to have applications. So that, in addition to a lot of interest from industry in these materials, pushed me towards always asking the question of 'ok, you invented a new structure, what is it good for?' My advice then is do it because you love doing it. If I had set out to solve the hydrogen storage problem, I may have completely missed the discovery of MOFs, COFs and ZIFs. Part of discovery has to do with a guided plan or a plan that is grounded in sound science. But also another part of it, a good part, is keeping your eyes open to what nature might be telling you to do. For example nature revealing itself in some structure that may emerge in a way you had not expected. So those two aspects are very important in making new meaningful discoveries.

If you weren't a scientist what would you be?
By nature, I enjoy doing solitary things and I am very good at learning things very quickly. I think that I would have made a good pianist or a good gardener. In both, nature reveals itself to you in a very measurable way-in the beauty of music and in terms of product in the garden. You cultivate your tree and at the end of it you get a very nice orange. Now you can see why I enjoy being a synthetic chemist because at the end of the day, I have a product in my hand that has colour, smell, character and shape. So you feel you've done something productive.

Related Links

Read more about Yaghi's work here
The Yaghi laboratory page at UCLA

External links will open in a new browser window

Also of interest

Secondary building units, nets and bonding in the chemistry of metal–organic frameworks
David J. Tranchemontagne, José L. Mendoza-Cortés, Michael O'Keeffe and Omar M. Yaghi, *Chem. Soc. Rev.*, 2009, **38**, 1257

DOI: 10.1039/b817735j

The pervasive chemistry of metal–organic frameworks
Jeffrey R. Long and Omar M. Yaghi, *Chem. Soc. Rev.*, 2009, **38**, 1213
DOI: 10.1039/b903811f

Instant insight: Nothing but surface
Alexander Czaja and colleagues discuss the possible applications of metal-organic frameworks for the chemical industry

Metal organic frameworks do the twist
Rotating solid-state crystals could outperform liquid crystals for optoelectronic applications, claim US scientists