JONATHAN WILKER

Inorganic chemists get cooking

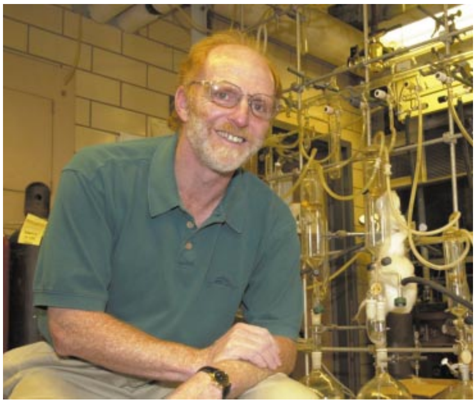
Sticky problem: mussel adhesive is just one example of a useful biomaterial attracting the attentions of inorganic chemists.

The research boom in biology is helping to reshape classical chemistry disciplines, providing fresh challenges for inorganic chemists, says Steve Bunk.

If 'interdisciplinary' is the byword for today's science, then chemistry must be its exemplar. So interlaced are its various activities that the categorical relevance of chemistry's classical disciplines — organic, inorganic, physical, analytical and biochemical — is a topic of continuing debate. For inorganic chemists, this development might seem worrisome, given the huge escalation of work generated by advances in molecular biology. But even in the life sciences, collaborations now include inorganic chemists, giving them a broader employment base than ever before.

"One can say tongue-in-cheek that organic chemistry studies one element and inorganic chemistry studies the other 117," says Bruce Bursten, chemistry chair at Ohio State University. Bursten is also chair of the inorganic chemistry division in the American Chemical Society (ACS), which is further subdivided into organometallic, solid-state and bio-inorganic chemistry. At executive committee meetings, he is raising the question of whether new subcategories should be recognized by the ACS, although he declines to anticipate what they might be.

Bruce Bursten sees inorganic chemistry as a major part of chemical studies.

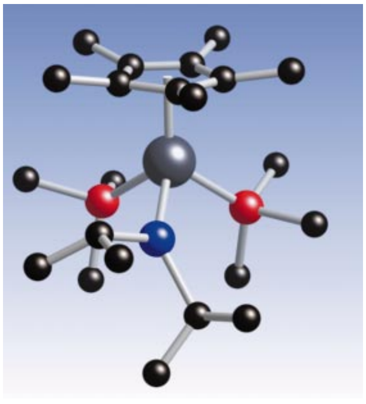


These classification issues might help to explain otherwise confusing evidence concerning the employment outlook for inorganic chemists. On one hand, the job picture is "exuberant across all sectors of the chemical enterprise", according to *Chemical and Engineering News*, which reports "the strongest employment situation for chemists in more than a decade". Yet, when 897 job openings were posted during the annual ACS meeting in April, only 1% were for inorganic chemists. And just 4.4% of the almost 1,000 candidates who filled out forms described their work as inorganic.

Moreover, the ACS forecasts flat or only slightly increased funding for research and development in the US chemical industry over the next few years because of intensified competition from abroad and an emphasis on cost-cutting. Bulk chemicals and petroleum, bastions of inorganic chemistry, have been particularly affected by the slowdown. But leaders in inorganic chemistry suggest that the job market is buoyant in both academia and industry. One explanation is that employment is growing in areas previously unavailable to the discipline.

"DNA and RNA don't do anything without a metal ion," declares Mike Clarke, programme director for inorganic

NSF



chemistry at the National Science Foundation in Washington. Of about 160 funding proposals submitted to the programme last year, half involved either bio-inorganic or organometallic research. A particularly strong growth area in bio-inorganics, says Clarke, is metal-centred-protein research. In organometallics, the hot field is asymmetric catalysis, which involves changing the 'handedness' of atom arrangements in pharmaceuticals, thus altering their efficacy.

Other major research areas, says Clarke, are solid-state chemistry, new inorganic materials, polymers and magnetics. Possible applications include computer components, such as high-density storage disks. "Most of our funding is for more basic research, but more and more we tend to connect that with something that's really going to be used."

RESEARCH QUESTIONS

This gives rise to the vexed question of whether an emphasis on applied research is harming fundamental research, and what the effects might be on working chemists. At the California Institute of Technology (Caltech), chemistry and chemical engineering are in the same division, and the chemistry faculty is arranged in groups that eschew the old classifications. "The traditional disciplines still play a role in how we organize ourselves; in particular, the way we teach undergraduate students," says faculty chair David Tirrell. But research no longer conforms easily to those categories, he adds. Caltech's faculty is grouped into activities such as catalysis/synthetic methodology, materials/polymers and theoretical/computational chemistry.

Not everyone agrees with such thinking. Iowa State University's John Corbett, who specializes in inorganic solid-state chemistry, suggests that new materials design is largely a "buzz-word". For example, "Nanosphere materials are fashionable but certainly not far enough along to develop a substantial number of graduates in those fields or a substantial number of jobs," he says.

Caltech inorganic chemist John Bercaw argues that "packaging people" to take advantage of heavily funded research areas such as nanoscience does not detract from developing core strengths in the traditional disciplines. Over the years, his own interests have embraced the inorganic study of nitrogen fixation, the biochemistry of nitrogenase enzymes, polymer science and hydrocarbon oxidation. This breadth of research, which he says is typical of chemists, is a result of collaborations.

"I don't think anyone would deny that federal funding in recent years has become more targeted to initiatives," says Bursten. But to him, the concern is that other worthwhile areas could be overlooked at the expense of hot fields. As a professor, his goal in preparing students for the job market is to teach them how to solve problems, he says, no matter which employment sector they enter. Accordingly, his own research is not pointed at applications. For example, his group recently created the first compounds that directly bond a noble gas with actinide. This new class of molecules has "no use whatsoever", he laughs.

John Corbett: sceptical about certain new materials.

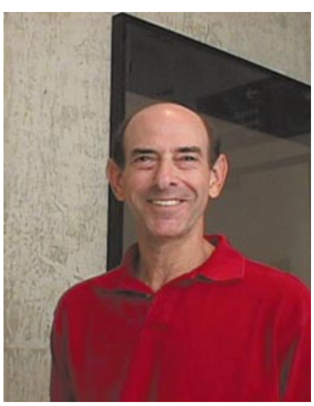
Richard Alkire, chair of chemical engineering at the University of Illinois, says that the improvement of product quality in his profession now often depends on an understanding of molecular dynamics. "Now the question is how you put together molecular systems and that's really different from digging down to find what mechanism or species is present," he says. Even so, he cautions, "People thinking about one thing all the time, even in the shower, should never become old-fashioned."

Alkire has chaired a series of chemical sciences 'round tables' in recent years, under the auspices of the National Research Council in Washington. Among his conclusions from these brainstorming sessions is that: "Universities have not worked out a mechanism for sustained interdisciplinary activities. They've worked out the birth mechanism but not the death mechanism." He means that, as yet, academia does not end its programmes well, making it difficult to transfer them to multidisciplinary centres. "The system is clicking into place, but it's probably more clunking than clicking," he says.

Inorganic chemistry is a growth area, according to Mike Clarke.

For inorganic-chemistry students, this creates the challenge of being well-prepared to enter a work culture that might emphasize organic skills. Here again, the interlaced problems of classifying disciplines and fundamental versus applied research present themselves. "It's the best of times and the worst of times in some ways, which means it's probably neither," says Richard Eisenberg, a University of Rochester professor and editor-in-chief of *Inorganic Chemistry*.

The bright side is all the new opportunities for inorganic chemists that are driven by achievements in molecular sciences, among them disease therapies based on inorganic systems or metalloenzymes, opto-electronics and new materials development. The dark side, says Eisenberg, is the effect on research. "In the way we judge proposals and particularly in the way new faculty formulate their proposals, application is not far away, which is not necessarily a good thing." The danger is that proposals can be motivated by applications that will engender no significant advance in science.



Richard Eisenberg: wants long-term commitment to solving industrial problems.

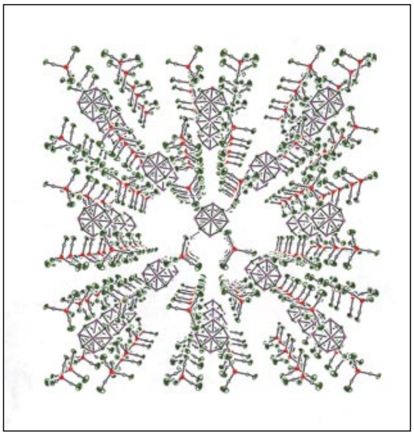
Eisenberg says the private sector once embraced the model of long-term commitment to science but quarter-to-quarter comparisons of sales now dominate R&D strategies. "I would like to see a long-term commitment to pursuing fundamental problems in industry," he says. He cites catalysts used in industrial commodity manufacturing processes as an example, saying that they should be re-examined in the context of environmentally benign chemicals.

Jack Arrington, leader for global R&D staffing at Dow Chemical, has a different take on applied science. "There is a distinction between applied and fundamental research, to some extent, but academia does what I would call curiosity-driven research," he says. The difference is that academics often have no profit motive. He believes that in industry, applied research can lead to fundamental breakthroughs.

Alkire agrees. "I think corporations have, to a large extent, moved past this entire problem. They work on problems that are complex, they work in teams and cross these boundaries," he says. "There's no loss of touch with basic science in industry."

Arrington says: "I think in industry there has probably been a longer history of large groups working together on a common goal than in academia." This has led to a broadening of the way jobs are defined in searching for new employees, but he notes: "We probably still describe the positions in most cases along the lines of classical disciplines." Although the company wants a scientist to carry out research in a particular area, it is expected that the employee's interests will broaden and deepen over time.

Rapid reaction: research into potential catalysts, such as this zeolite mimic, is important for industrial processes.



SHELDON G. SHORE

Arrington says that discussions with ACS representatives last summer indicated that the society was receiving a higher number of job-search requests from smaller companies than in the past, but he also points out that not all start-ups survive. Major companies seem to be hiring a smaller percentage of R&D people than in the past, but that reflects lower R&D budgets. "We're hiring at about, or a little above, the rate of attrition," he says. Until recently, organometallic chemists were in high demand at Dow for polymerization work. Those numbers are not as large now, giving way to employment of polymer chemists with some knowledge of materials engineering for electronics research.

At Ohio State, Bursten says that Dow interviewed for inorganic chemists in 2000 as usual, but he thinks the company's takeover of Union Carbide slowed down employment. The merger had been announced but was not finalized (it was completed last February), which Bursten believes "tied everybody's hands". Such consolidations of big companies do not bode well for employment, he says. "The days when most industrial chemists would get jobs at Union Carbide, Amoco, Exxon or BP are almost gone."

On the other hand, "The market for academic science is growing and will continue to grow," says Bursten. He cites solid-state chemistry as a big demand area, and Iowa State's Corbett affirms that US universities already employ up to 100 professors of solid-state chemistry. Opportunities are also growing for chemists who are willing to work in alternative fields. Jobs are proliferating in patent and environmental law, informatics and consulting, says the University of Rochester's Eisenberg.

What all this means for the education and training of inorganic-chemistry graduates is simply summarized, Corbett suggests. "The broader the better is an easy recommendation." ■

Steve Bunk is a freelance writer in Alexandria, Virginia.

The lone 'alchemist' survives

James Hall (right) says chemists must pay their dues.

Chemistry graduates who go to work for John Wasson are warned to expect the unexpected. "We tell them that with John, it's totally different from what they'll find in just about any other industrial environment," says James Hall, physics and chemistry chair at Wingate University near Charlotte, North Carolina, which supplies Wasson with his occasional helper.

Wasson says he does "bucket chemistry", Hall laughs. "And it's literal. Instead of beakers, he'll go to a supermarket and buy five-gallon buckets to use as reaction vessels." For mixing, he mounts paint stirrers on drill handles.

The company, Advanced Materials of Newhill, North Carolina, makes inorganic and organometallic chemical compounds for research and industry. Aided by his son, who is trained as a chef, and the odd graduate assistant, Wasson mostly does the work himself. In providing lab supply-houses with unusual, custom-made products, he has created hundreds of new materials every year since 1989.

"The cooking aspects of inorganic chemistry have been a mainstay of my academic and business life," he says. Trained in inorganic and physical chemistry, he did academic stints at the Universities of Kentucky and North Carolina before becoming director of chemical research for a major lithium manufacturer. In the 1980s, he co-founded two chemistry companies, one of which became a large-scale producer of lithium acetate. He says of his current business: "The biggest thrill for me is still to know I have the world's supply of a compound nobody ever made before. I can jump up and down on the desk and scream, 'You are a god!'"

Hall says he would tell any student who wanted to follow Wasson's career lead: "You've got to pay your dues, and remember how to make all the compounds you've ever made." S.B.

Web links

American Chemical Society career services
➧ **http://www.acs.org/careers**

Chemical industry search engine
➧ **http://www.chemindustry.com**

National Academies Board on Chemical Sciences and Technology
➧ **http://www4.nationalacademies.org/cpsma/bcst.nsf**