Dirk G. Kurth

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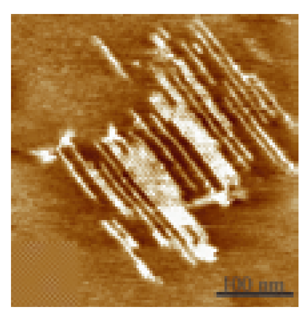
For 40 days a year he finds himself immersed in another culture. **DIRK G. KURTH** *from the* **MAX PLANCK INSTITUTE OF COLLOIDS AND INTERFACES** *in Potsdam spends part of his working life as the youngest – and the first foreign – Director at the* **NATIONAL INSTITUTE FOR MATERIAL SCIENCE** *in Tsukuba, Japan. His task there is to develop a department specializing in "supramolecular functional materials" – a challenge that requires more than just a knack for science.*



The supramolecular modules synthesized by the group headed by Dirk G. Kurth spontaneously arrange themselves as nano-rods on a graphite surface.

PHOTOS: NORBERT MICHALKE/MPI OF COLLOIDS AND INTERFACES

"I hope I can bring some of the friendly and relaxed atmosphere back to Germany with me." The mindset that Dirk G. Kurth, a chemist at the Max Planck Institute of Colloids and Interfaces in Potsdam, encounters daily in Japan has made a deep impression on him. He is just back from his third trip to the "land of the rising sun." Raised voices are rare, he says, and aggressiveness unknown. The reason that Kurth is able to gather these and other experiences lies in the fact that, at present, Potsdam is not the only place he calls home. He is also researching at Japan's NIMS (National Institute for Material Science) in the scientific city of Tsukuba, northeast of Tokyo. At the age of 40, he is the youngest, and above all, the first foreign Director to be appointed there.

Dirk G. Kurth is justly proud – he knows, after all, what the NIMS means to the Japanese. He describes the situation thus: "They aim to be the world's number one. So three years ago, they embarked on a major restructuring program to amalgamate several institutes. The result was NIMS, which Japan hopes will take a leading position in the material sciences." What's more: "When the Japanese put something on the political agenda, they see it through." The Japanese strategy, as Kurth describes it, is to look far ahead into the future, identify new key technologies and focal points for research, and then create the infrastructure needed to do the job. Another element is a desire to be more open on an international front, which includes bringing the best scientists to Japan, and with them, the requisite know-how.

In the course of their search, the Japanese took notice of the German Max Planck researcher. It's not hard to guess why. More than 70 publications attest to his scientific creativity, and the time he has already spent abroad in the U.S. and France shows that he is quite at home anywhere in the world, and keen to experience new things. Following their visit to Potsdam, the Japanese delegation were convinced not just that he was professionally qualified, but also that Kurth would cope admirably well in their country. His friendly personality, quiet manner and open acceptance of other traditions all stand him in good stead.

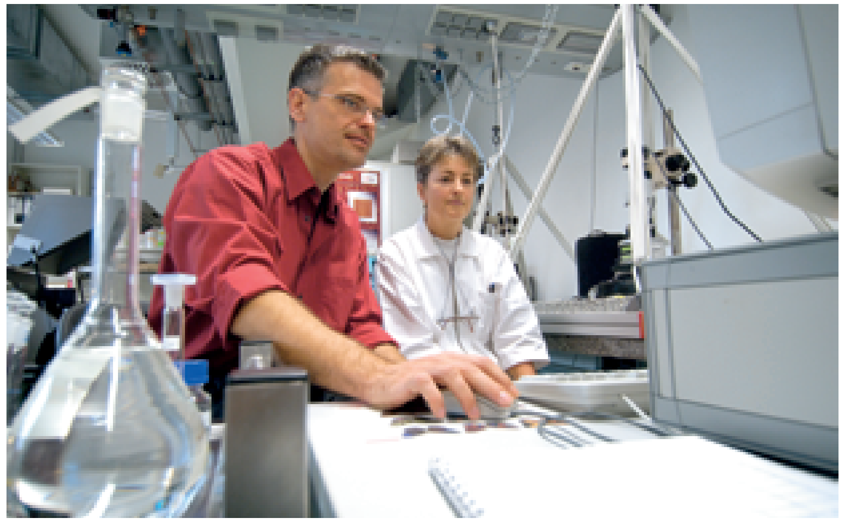
DREAM OFFER FROM THE FAR EAST

"The offer from Japan was irresistible – simply fantastic," says Kurth. With a budget of around two million euros, over the next three years he will be able to establish a department for supramolecular functional materials. Dirk G. Kurth spends about 40 days per year in Japan, developing and implementing new ideas together with NIMS researchers. The rest of his time is spent at his home institute in Germany. In the absence of the Director, the day-to-day business in Japan is handled by a deputy who also makes regular visits to the Max Planck Institute in Potsdam for discussions, planning meetings and scientific activities. It is likely that he himself will one day become a Director.

Even while he was a student, Kurth had made up his mind to write his dissertation in America. However, a closer look reveals that, for all of his meticulous planning, he always remains open to new challenges. He takes note of exciting developments and is keen to get involved. A case in point occurred while he was a doctoral student at Purdue University in Indiana (USA), focusing on the manufacture and spectroscopic characterization of self-organizing monomolecular layers. Jean-Marie Lehn visited the institute to give a lecture on supramolecular chemistry. Even beforehand, after reading an article in the German-language magazine ANGEWANDTE CHEMIE, Dirk G. Kurth was fascinated by the world of weak interaction revealed by Lehn, winner of the 1987 Nobel Prize for chemistry.

The concepts and ideas, the shear potential offered by hydrogen bonding and similar intermolecular forces had him in their grip. And when Kurth listened to Lehn's lecture, he was convinced that he wanted to spend his postdoctoral time with Lehn. The two men spoke, and in June 1994, Kurth found himself in Strasbourg. He spent just under two years at the Université Louis Pasteur – a time that he describes as fruitful and formative. "The atmosphere there was unique. Everything was internationally oriented. There were 20 of us welded into a team in next to no time." Dirk G. Kurth has fond memories of stimulating discussions with his colleagues. Jean-Marie Lehn himself regularly visited the laboratories, was always well informed, and had something to add to every conversation – be it technical or social.

In terms of the intellectual benefits, says Kurth, his time in France was the richest in his career to date – even if Albuquerque, New Mexico, where he spent his first year and a half in the U.S. in 1989/90, scores



A team player by nature and a scientist by conviction: Dirk G. Kurth of the Max Planck Institute of Colloids and Interfaces with laboratory technician Anne Heilig, working with the scanning force microscope.

highest for its landscape and quality of life. "But it was in Strasbourg that I learned to think in entirely new ways. I discovered how to design molecules, what forces and interactions you can use, and that the point is always to keep the syntheses of these molecules as simple as possible." Today Kurth, who began his study of chemistry in Cologne, uses this knowledge to produce supramolecular self-generating structures.

As the head of his own working group at the Max Planck Institute of Colloids and Interfaces, he has long since become an idea-man. The fact that he is not now himself an inhabitant of the laboratory is something he no longer misses. "In those days, in America, when I was heavily involved with spectroscopy and other optical methods – in other words physics – I missed the chemical laboratory work. But in Strasbourg I was able to really indulge myself with synthetic chemistry." Creativity in the laboratory was a powerful experience, he says. As head of a research group, he now enjoys discussions with his students, post-graduates and postdocs, developing, coordinating and implementing new ideas. His own experiences in the laboratory come in very handy. As do the lectures he gives in his capacity as external lecturer at the University of Potsdam.

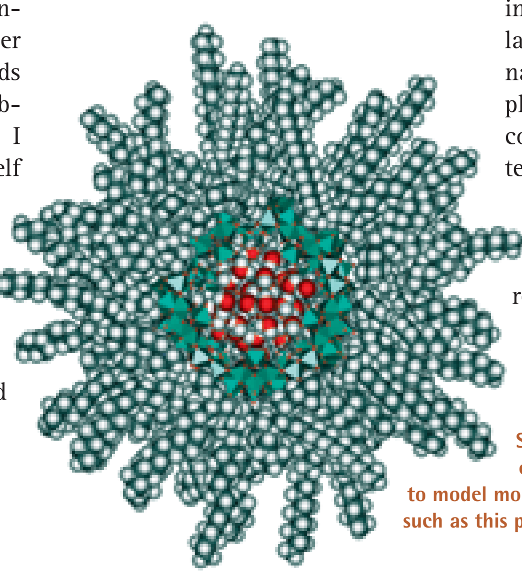
Researchers Play Molecular Legos

When asked to describe what he and his colleagues and partners actually do, Kurth resorts to the term "molecular Legos." After all, "it's like joining little building blocks together to form larger structures. But the best part is that the molecules do this of their own accord. We design the molecules and construct the interactions so that the individual bricks organize themselves into complex architectures." All the chemists have to do is select suitable molecules and create the right conditions, for example by choosing the concentrations of individual building blocks.

Since 1996, Kurth has found the ideal conditions for his scientific work at the Max Planck Institute of Colloids and Interfaces, in the department headed by Helmuth Möhwald. The ideas behind this molecular Lego game, which Dirk G. Kurth brought with him from Strasbourg, convinced Möhwald, himself a physicist, to support a post-doctoral chemist on his way to becoming a professor. Their interdisciplinary cooperation, which has endured for some eight years, might well be described as waving a chemical magic wand and using physics to investigate the results.

At the heart of the functional materials that Kurth creates, there are always metal ions that form complex combinations with various organic ligands. His team has, for example, been successful with so-called bisterpyridines. These ligands were first described in 1991/92 by the British chemist Edwin Constable. Dirk G. Kurth found these ligands appealing and became the first to use them to build macromolecular functional units. "The ligand is neutral, the metal ion is charged, and we use this to create water-soluble polyelectrolytes," says Kurth. The polyelectrolytes can then be precipitated at interfaces. The results include monolayers, Langmuir-Blodgett films, nanostructures, liquid crystalline phases and other architectures that could also have interesting nanotechnological applications. Today, the Max Planck researchers, together with their cooperation partners, have access to a whole repertoire of methods that enable them to build such structures.

And because the individual building blocks are held together only by weak interaction, some of the properties of the resulting functional materials appear to be very promising. In response to external stimuli, they can change their structure or function and adapt to their environment. This opens the way for entirely new technologies – for instance, materials that can heal themselves. The spectrum of possibilities is unlimited, says Kurth, offering something for everyone. The use of weak intermolecular interaction to build functional materials has thus developed into the guiding principle of nanoscience and chemical material research in recent years.



Scientists use computer calculations to model molecular structures such as this polyoxometalate cluster.

Photos: Norbert Michalke/MPI of Colloids and Interfaces

Since obtaining his doctorate and pursuing his postdoctoral studies, Dirk G. Kurth has succeeded in doing what he set out to do: combine supramolecular chemistry and the possibilities it offers with what he learned in America while manufacturing and characterizing thin films. "The numerous structures that can be created by weak interaction also offer a host of fascinating physical properties," he concludes. Electrochromic, photochromic and magnetic properties, for example – not to mention catalytic and sensory functions. "It is clear at least that the structures are not only important for basic research, but also that they might well have direct applications."

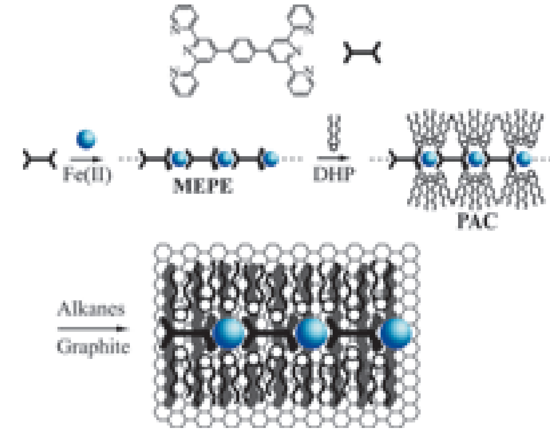
It is this broad spectrum of potential that fills Dirk G. Kurth with enthusiasm. And he promptly shows great delight when talking about his work – for example, when he describes the recent occasion when Spanish post-doc Jesús Pitarch López discovered something totally new and unexpected: a kind of "molecular selection." This is a system comprising two different ligands and one metal ion that, in solution, forms three different complexes. However, only one compound crystallizes out of the solution. "One species sorts itself out of the mixture," explains Kurth, "as if we had instructed the molecules to produce only one product. And what's more, it is the most interesting of the three compounds." In further experiments, however, it was initially impossible to replicate these measurements. That, too, is part of everyday research life.

"The Japanese Are Extremely Successful"

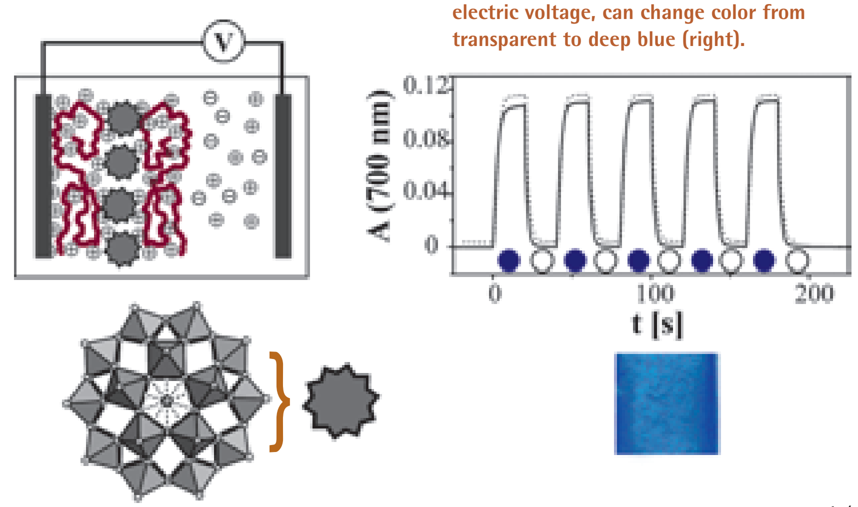
When Dirk G. Kurth first began to study chemistry in Cologne in 1984, he found a job during semester breaks at Bayer Leverkusen, where he became engrossed in technical chemistry and the idea of transferring laboratory-scale processes to huge plants. In order to study technical chemistry, he switched to the RWTH, a specialist technical college in Aachen. It was there that he was first gripped by a fascination for basic research – a grip that, to this day, has not loosened. He has already held a professorship for more than a year now.

The fact that a Director is treated almost like a king in Japan takes some getting used to but, he admits with a grin, so much attention is not entirely unenjoyable. "Even if I am the kind of person who prefers flat hierarchies – such as those at the Max Planck Institute," he adds. In Japan, on the other hand, it is hierarchical differentiation that defines social interaction. No one sits until the Director has taken his seat. And when he leaves an event, everyone leaves. Of course, says Kurth, his colleagues in Japan are pleased by any efforts to adopt their manners. But their calm composure remains unruffled by a failure to remember all of the subtleties of Japanese etiquette – harmony is, after all, the primary objective. On the other hand, "The Japanese, for all their finely graduated social organization, are extremely successful," says Kurth. One more reason, then, to devote time and attention to the country and its way of life in order to understand the Japanese secret to success and bring some of that understanding back home.

Ina Helms



Simple but complex: The interaction between inorganic and organic molecules that spontaneously organize themselves into highly structured mesophases with interesting magnetic properties.



The functional unit, a polyoxometalate cluster (left), is formed by the spontaneous amalgamation of molecular sub-units. Integrated into a thin film between two transparent electrodes, a window is created which, with the application of an electric voltage, can change color from transparent to deep blue (right).

Graphics: MPI of Colloids and Interfaces