

Ulrike Krewer



*The title "Frau Dr.-Ing.," which is used to address female engineers in German, is not as rare today as it was two decades ago. Today, it is even possible to find women engineers whose careers take a more unusual path than those of their male colleagues – like the career of **ULRIKE KREWER**, for example. The 32-year-old process engineer researches fuel cells at the **MAX PLANCK INSTITUTE FOR DYNAMICS OF COMPLEX TECHNICAL SYSTEMS** in Magdeburg.*

PHOTO: BASTIAN EHL

Engineers are still 'real men.' They are easy to recognize as students, thanks to their penchant for wearing plaid shirts with their jeans and the ease with which expressions like "flange," "torque" and "that only runs under Linux" flow from their lips. They design avant-garde skyscrapers for Dubai, work on fuel-efficient engines, and provide clean drinking water in the crisis-ridden regions of the world.

Engineers are seen as down-to-earth, reliable and, on a private level, "technical saviors." Before putting the drill to the wall, they automatically know that the small anchor is much too weak for the shelf. And it goes without saying that it is beneath their dignity to call roadside assistance when the car acts up. Women who have one of this species at their side are sure to be the envy of their friends.

However, the "engineer = man" equation is no longer a universally applicable one. Female chemists and physicists have been around for some time, and the walls of what is probably the last of the male academic bastions – the engineering sciences – have long been crumbling. While, in 1981, fewer than 10 percent of engineers or "Dipl.-Ing.'s" who graduated from a German university or university of applied sciences were women, 25 years later, almost every fourth degree is conferred on a female engineer.

All of this is completely normal for "Frau Dr.-Ing." Ulrike Krewer. Nothing whatsoever to make a fuss about. After all, the 32-year-old did not study process engineering for reasons of sexual emancipation, but because she wants to achieve something in the area of technical environmental protection. "And not working on 'end of pipe' solutions – that is, struggling to clean up the dirt

created by other people – but on new technologies that are sustainable from the outset," as she says herself. This is exactly what she is doing now as Head of the Otto Hahn Group Portable Energy Systems at the Max Planck Institute for Dynamics of Complex Technical Systems in Magdeburg. She is researching direct methanol fuel cells at the first – and to date only – institute of the Max Planck Society devoted to the engineering sciences.

It is a cliché, but it is nonetheless okay to ask: "What does a little girl who wants to become an engineer play with?" Ulrike Krewer considers the question briefly, smiles, and says: "A highway with a parking lot! The cars were able to access the road directly from the parking decks. I made that for myself when I was seven years old." Were there dolls too? "Of course. My little sister and I competed to see who could collect the most Barbies. But the Lego box was equally popular."

FAMILY BIAS FOSTERED CAREER ASPIRATIONS

Ulrike Krewer grew up in a small village near Trier in southwest Germany ("... more cows than inhabitants"). There was no bus service to the city on Sundays, and the last bus on Saturdays left at 7 p.m. Quite difficult for a teenager – but there was plenty of space to run around to compensate. Up to the 10th grade (age 16), she attended a high school for girls ("... every third teacher a nun"). Math was her favorite subject, later to be joined by chemistry. Physics? "No, but that was due to the teacher." Nor did her aspirations to become an engineer just come out of nowhere. A certain family bias also played a role here: Krewer's father is a civil engineer. Graphic design was a possible alternative. "Nonsense," her father

grumbled at the time, "You should become an engineer!" It really would have been silly, she says today. Her upbringing also fostered her strong awareness of the environment. The University of Erlangen has a department of environmental process technology. Just three of her fellow students in her first semester were women. She was not fawned over by the professors, who were all men. "But there was no rejection or sexism at any time," she recalls.

As a student, Ulrike Krewer was an active member of Greenpeace for a few years. Discussing ecological problems in work groups and defending the theories emanating from the organization's headquarters in public "was very exciting because it was such a contrast to the technical content of my studies," she says. The opportunity for her to do something concrete and sustainable for environmental protection herself soon arose through her practical, hands-on undergraduate thesis. The young woman went to the Indian Institute of Chemical Technology in Hyderabad in southern India for five months. There, she developed a software program that could be used to optimize industrial chemical processes. The aim of the project was to enable industry to use fewer but more suitable and, above all, more environmentally friendly solvents in synthesis processes.

The chemical industry operates completely differently in an emerging country like India than in Germany, explains Krewer: "There are many small industrial companies in which production involves pouring substance A from a bucket into a barrel of substance B, with something or other being produced as a result." Gloves and masks? Not a chance! "So it helps if a suitable solvent can be used from the outset. One that evap-

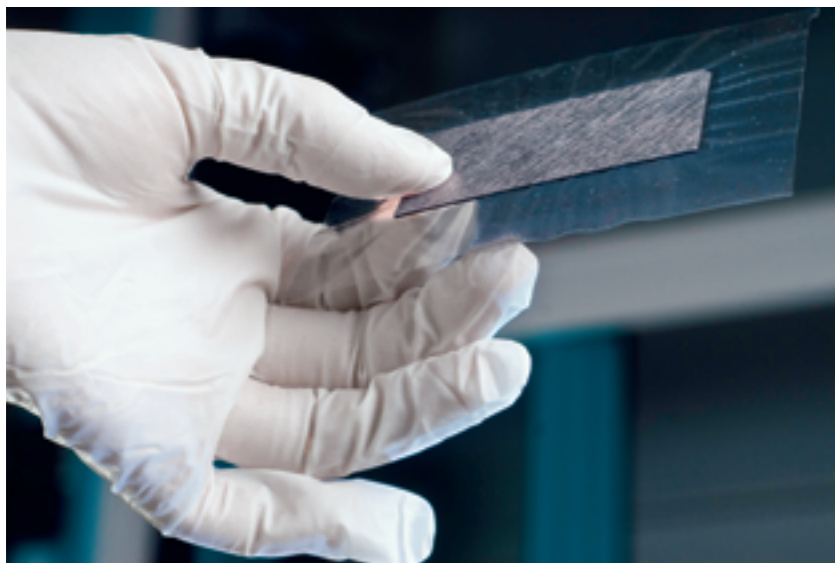


PHOTO: BASTIAN EHL

The heart of the fuel cell: The two black electrodes are separated by a membrane.

orates less and is not so harmful in terms of its ozone impact.”

Krewer’s program characterizes, based on the functional groups present, the molecules that react with each other and their solubility, and creates a ranking of the best solvents according to factors such as environmental impact, global warming, and toxicity.

Environmental protection is one motivating factor behind Ulrike Krewer’s work – experiencing first hand how people from other cultures live and work is another. She has seen half of the world already, having visited China, Japan, Korea, Thailand, Jordan, Israel, Hungary and Slovenia, among others. Her trip to India was also very exciting. “There may be less technology available there, but things get done somehow,” says the Max Planck researcher.

DANCING OUT STORIES ABOUT THE GODS

She was very impressed by the Indians’ philosophy and attitude toward life. “They are far more balanced and less aggressive than us,” she notes. That complex phenomena outside

science can also have their attractions is something she experienced first hand when she learned Kuchipudi, the local classical dance. She was instantly fascinated by the combination of rhythmical music, complicated technique – hands, feet and gestures must all be perfectly coordinated – and the religious background: an hour of “dancing out stories about the gods” became her daily exercise program in India.

Back in Germany, Ulrike Krewer decided to do her Ph.D. on direct methanol fuel cells (DMFC). Hydrogen-powered cells are still the standard at the moment. “Admittedly, hydrogen generates four times more power density than methanol, but the fuel is very difficult to store,” she explains. Methanol is not nearly as flammable as the compressed bi-atomic gas.

Krewer applied to work in various institutes and then decided to join Kai Sundmacher’s group at the Max

Planck Institute in Magdeburg. “I was impressed by the way he works: not just fiddling around with one parameter, but gaining a complete understanding of the entire context through solid basic research.”

However, because methanol is produced from natural gas, the electricity produced using DMFCs is not as environmentally friendly as that generated using solar cells, wind mills, and tidal power plants. (Biomass is a possible alternative source that may be available in the future.) Nevertheless, compared to traditional electricity generation, energy from DMFCs produces no soot and far less waste heat. The attraction of this method lies in the way chemical energy is converted directly into electrical energy without the need to first convert it to thermal and mechanical energy: methanol is oxidized and air reduced on electrodes coated with platinum-ruthenium or platinum particles, respectively, which are separated by a synthetic membrane. The only products generated are pure electricity, water and carbon dioxide.

SILENT POWER PLANT REPLACES WALL SOCKET

The effective efficiency of methanol fuel cells is approximately 60 percent; a normal power plant obtains a maximum of 40 percent from coal. Other advantages include the fact that, because they do not contain any mobile

parts, fuel cells work almost completely silently and, depending on the power requirements, can be connected in series like traditional batteries. The crucial difference between fuel cells and batteries, however, is that the former do not store energy, do not discharge and thus need no recharging: they generate electricity continuously when required until the attached fuel tank is empty.

Such cells are already used in the caravanning sector. They make it possible to watch television by lamp-light in the middle of nowhere where there are no wall sockets. Previously, the alternative was a loud, petrol-operated “rat-a-tat-tat” generator. The technology is also already being used in yachts: fuel cells guide them safely and quietly into the harbor when engine use is prohibited by water protection legislation. These electricity generators, including their methanol cartridges, are still the size of three shoeboxes – at 60 watts. “Not very compact for the power produced,” as Ulrike Krewer notes.

The fact that DMFCs are not yet available on the mass market and are still not used for powering computer notebooks and cell phones is due to such problems as voltage fluctuations. These arise when a surge in the power requirement is applied to the cell. This happens, for example, when a CD is inserted into the laptop: the fan switches on immediately and the



Ulrike Krewer carefully documents how the fuel cell works.

device needs more power for a time. Ulrike Krewer studied such processes and found that the voltage does not simply drop after this, but that a power change causes overshooting of the cell voltage curve. A curve form is produced that is reminiscent of an ECG showing cardiac malfunction. Krewer’s analyses found that the three reactions that take place on the anode during methanol oxidation occur in parallel or in sequence, but at different speeds, and their interaction is the cause of the overshooting. She received a dissertation award from Otto von Guericke University in Magdeburg in 2006 for this groundbreaking work.

“I then pursued this research further at Samsung in South Korea,” reports the scientist. Her choice of location was no coincidence, as most of the world’s fuel-cell prototypes are produced in Japan and Korea. For two years, she worked as Senior Engineer in Samsung’s Energy Research Center in Suwon, 50 kilometers south of Seoul. Her boss was also a woman. “A real hard-core engineer who had her first child immediately after completing her dissertation, and then handed it over to her husband after eight months and went abroad for a year,” says Krewer.

THE GROUP AND FUN: WHAT MATTERS IN KOREA

Do women engineers research differently than their male colleagues? She considers the question. “Perhaps we are not quite as smitten with technology as the men. Admittedly, I like playing around with the cell, too, but what ultimately matters to me is the development of a more energy-efficient device.”

Her experiences in Korea were similar to those gained earlier in India: brooding German types who work in

If the chemistry is right, the electricity flows: Methanol is oxidized to carbon dioxide at the anode and emits electrons. The latter reduce oxygen to water on the cathode.

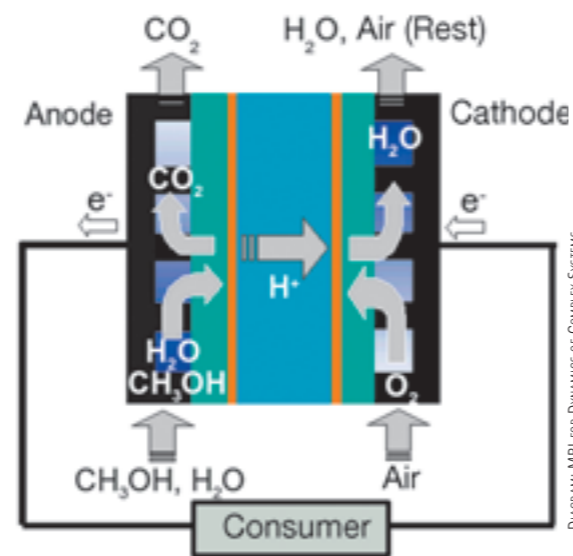
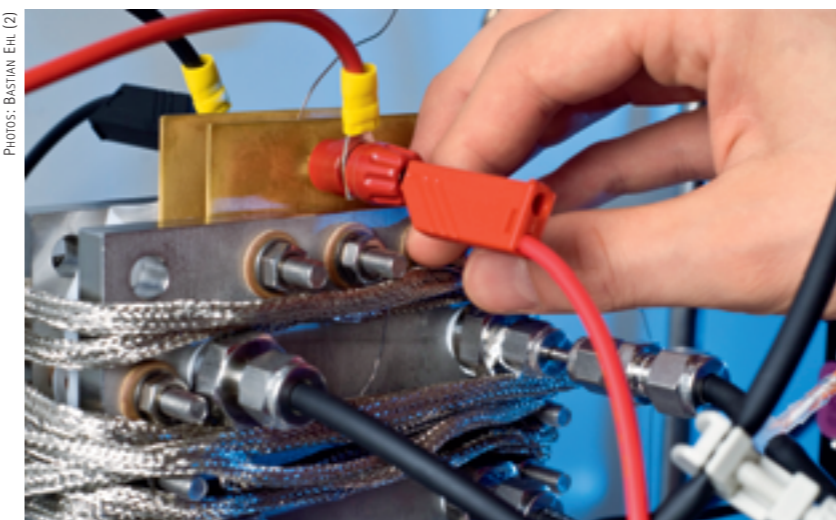


DIAGRAM: MPI FOR DYNAMICS OF COMPLEX SYSTEMS



PHOTOS: BASTIAN EHL (2)

Is everything properly connected? Then the fuel cell powers a light bulb.

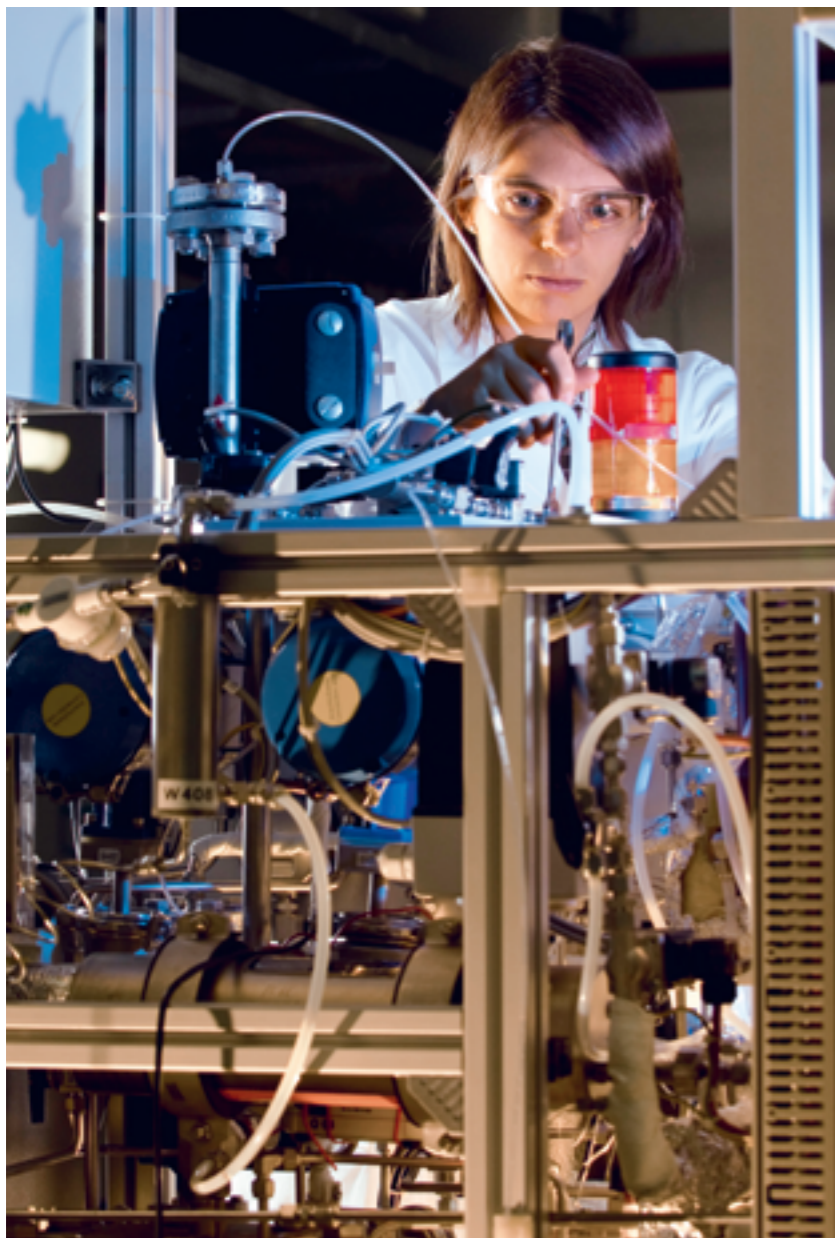


PHOTO: BASTIAN EHL

sider"). Even the characters, which are utterly indecipherable to the uninitiated, were easy to learn. "For every syllable, there is a symbol composed of the individual letters arranged in a clockwise direction." She immediately grabs a pen and sketches the structure of the letters and syllables. It's obvious how the almost mathematical logic behind it would have had an immediate appeal for her.

She also learned Taekwondo – although not for self-defense purposes, as she had already earned enough respect. She laughs. "For Heaven's sake! The woman is tall, speaks out, and when things get serious, she will not respect my personal space," is what her colleagues thought of her. When she was leaving, the director of the research center said to her, with a smile, that she had always been very aggressive in her approach. A clear compliment: she had earned his respect, too.

ULRIKE'S FUSION IN HER OWN KITCHEN

Ulrike Krewer was awarded the Otto Hahn Medal of the Max Planck Society in 2007. She had briefly considered continuing to work in industry in Korea – but ultimately decided against it. "You cannot really get to the bottom of problems there, but just hope that one of the paths taken will lead to your objective before the project changes direction," she says. So she was happy to accept the offer that went with the medal, to establish a junior research group at the Max Planck Institute. "Fuel cells – now for real!" is the plan she has been putting into action since her return to Magdeburg.

In addition to the Asian group dynamic – she deliberately shares an office with her colleagues – she brought back a preference for light cuisine from Korea. This mainly takes the form of "Ulrike's fusion" in her own kitchen at home, as there is not a single Korean restaurant in all of Magdeburg. What a pity, as she would not have had to point and say "Number 32, please," and would have been

able to order in Korean. "Even with or without meat" – an important detail, as she is a vegetarian.

Ulrike relaxes after work by doing karate or reading. At the moment, the main focus of her reading is the Weimar Republic, as she has a soft spot for history. There is only one thing she misses in Magdeburg "My boyfriend!" He works in a different city. They have had a long-distance relationship for six years, a situation unlikely to change for the next five years, and a fate that Ulrike Krewer shares with scientists all over the world whose career is equally important to them as family, if not more so.

For the time being, she is taking it easy in this regard. Children? "Probably not." Not for now, at least. Research is her top priority. She would like to teach students herself at some point, a wish that may be fulfilled in a few years; being head of a junior research group is an ideal spring-

board to a professorship. At this academic altitude in Germany, the air for female engineers is nearly as thin as it is on Nanga Parbat: only 6 percent of the professorships at German universities are held by women.

A SCREWDRIVER AS A PERSONAL ACCESSORY

Until then, Ulrike Krewer will continue her systematic study of portable fuel cells. The scope of application for this power pack is enormous. They would be useful anywhere where electricity is needed and there is no grid, or where batteries discharge too quickly. Submarines can already remain quietly at diving stations for weeks with the help of such fuel cells. The University of Magdeburg backs up the emergency power supply for its hospital with a 250-kilowatt fuel cell power plant.

The cells also are also stoically resistant to extreme environmental

conditions, whether hot desert winds or sub-zero temperatures. The methanol fuel cells at the Neumaier II Arctic research station, for example, provide electricity for scientific experiments when not a single ray of sunshine touches the solar cells and the wind generator has long been shock frozen. All they need is a bit of methanol once a month.

Ulrike Krewer is playing her part in ensuring that this technology will soon work perfectly in smaller formats, too, and that fuel cells become the "power plant for the handbag," the title she gave to a recent lecture, and an image at which her mentor Kai Sundmacher may well shake his head with an amused smile. Even though her personal accessories now also include an oil-smeared screwdriver, when it comes to her handbag, a brilliant female engineer like Ulrike Krewer still thinks just like any other woman. CATARINA PIETSCHMANN

Ulrike Krewer needs to fit screws so often that she always carries a screwdriver with her.

isolation to solve tricky problems are not in demand. "Ms. Krewer, smile! You should be happy!" was the reaction when she was observed tensely mulling over some problem or other. What counts is the group and the enjoyment of work. "You set yourself an objective – without formulating endless applications in advance down to the very last detail – and then, everyone takes off together: Palli palli! (Quick, quick!). It was a wonderful experience."

Her western attitudes did not get her very far in her private life, either.

The Korean desire for harmony is so strong that controversial discussions are seen as a faux pas, even after work, over an evening meal in a restaurant. "When I go out, I like to have interesting conversations and say what I think. In Korea, you do that once and people will never go out with you again," says the researcher.

For a confident, communicative woman like Ulrike Krewer, this took a lot of getting used to. She learned Korean quickly to facilitate her integration ("although you can spend half your life there and still remain an out-