In her element

“For material scientists, the market for medical products is an exciting prospect, but it’s challenging too.”

Biodegradable bone implants could one day become a reality, thanks to Nicole Kleger. The former Excellence Scholar is a doctoral student in the Complex Materials group – an extremely productive research environment.

She specialises in 3D printing of porous materials. That may sound a little dry, but hearing Nicole Kleger describe the process makes you realise that this is a fascinating field. In nature, porous materials frequently occur in places where they have to withstand tremendous mechanical load. One of the best examples can be seen in our own bones. Until now, however, people have tended to focus on other applications for porous materials, such as filtration (diesel particulate filters), protection (Styrofoam) and insulation (bricks). They have rarely been considered for their ability to resist major mechanical stress. “We don’t understand these materials well enough yet,” comments Nicole Kleger.

In addition to her fundamental research, the material scientist is investigating a specific application: porous magnesium for bone implants. It is difficult to 3D print magnesium directly. As part of her doctorate, Nicole Kleger is developing a method of manufacturing magnesium with structured porosity using a 3D printed salt template. This can then be processed to produce a magnesium implant. One advantage a magnesium implant has over the customary titanium implants that are used for complicated bone fractures, or where sections of bone are absent, is that the body is able to break it down and absorb the magnesium as a mineral. Another advantage is that bone-forming cells are able to grow into the pores, accelerating the healing process.

An idea that deserves funding

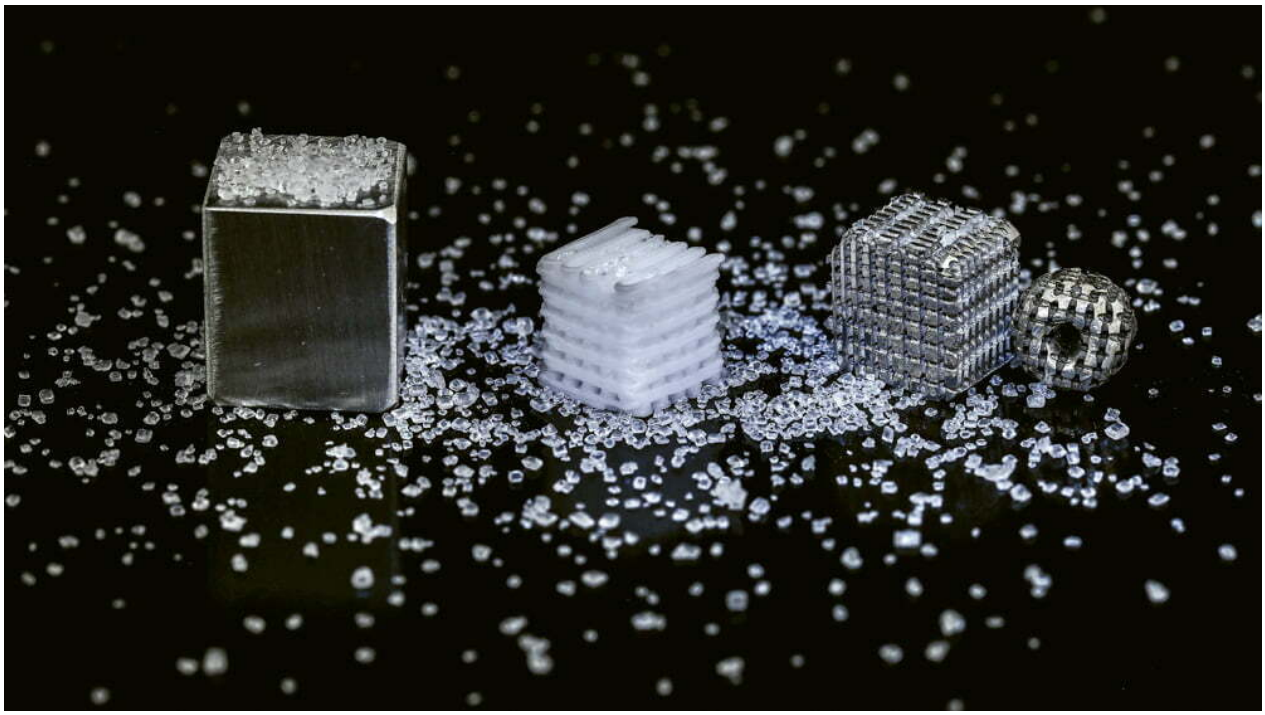
Introducing medical products using new materials is a challenging process. Nicole Kleger estimates that it could take up to ten years for her implants to reach the market. But, as she points out, “What makes my method of 3D printed salt so interesting is that it can be transferred to other materials and areas.” The idea first arose while Nicole Kleger was working on her Master’s thesis. She was funded by donors through an Excellence Scholarship. “I always appreciated being able to exchange ideas with the donors,” the doctoral student recalls.

Nicole Kleger is the granddaughter of Alfred Schai, who supervised the assembly of the vast ERMETH computer at ETH Zurich during the 1950s. The 28-year-old grew up in Weiningen in the Limmat Valley, where she and her family still live today. Her fascination with natural sciences was evident early on. “My father used to call me Gerda Conzetti after the presenter of a popular arts and crafts series on television. I was always pottering away at something.” But the young researcher was also very much drawn to abstract reasoning and her favourite subject at school was maths.

How talent thrives

In discussing her current research environment, Professor André Studart’s Complex Materials group, Nicole Kleger points out a number of positive aspects. “The unique thing about our group is that it has an extremely broad basis that includes microfluidics, 3D printing, composite materials and much more. Because we take our inspiration from natural materials, we use a diverse range of technology.” Accordingly, the lab attracts people from a range of different backgrounds, including mechanical engineering, physics, electrical engineering and food sciences. “The big advantage here is that, whenever you need inspiration, you’re always going to come across someone with a good idea.” The lab has a high profile, thanks to promising spin-offs such as Spectroplast (silicone 3D printing) and FenX (recyclable insulation foam). “It’s cool that the start-ups are an integral part of our group. It helps us to see the practical relevance of our research.”

Nicole Kleger describes the atmosphere as cooperative, with flat hierarchies. “André really encourages us to socialise, for example with the weekly group breakfast.” The mother of two feels that, with proper support from your supervisor, doctoral studies and parenthood can be combined well. “We’re very flexible – we don’t depend on each other’s schedules. Even André sometimes has to leave at 5 o’clock to pick up his children. You can put in some extra hours later, when the children are in bed, for example.” Nicole Kleger sees her future in a postdoc or a startup, perhaps even one of her own. For the time being, though, she is putting her energy into her “first baby” as she calls it – 3D printed salt.



How do you turn salt and magnesium (left) into a bone implant (right)? By using a 3D printed salt template (centre).

Support the ETH Excellence Scholarships

Educational opportunities

Funding from the Alexander Tutsek-Stiftung in Munich (www.atutsek-stiftung.de) has enabled André Studart’s group to create a new “Powder Processing Lab”. Here students can learn ceramic manufacturing processes and gain access to the latest processing and analysis tools and equipment for their own projects.