Using the piezoelectric effect to make better implants

Imagine a bone implant that actively stimulates the recovery of the damaged tissue slowly dissolves inside your body as it's taken over by your own bone.

This new kind of implant is not a reality – yet. But, if Julia Glaum and her colleagues have anything to do with it, it could exist one day.

Glaum, an associate professor in the Department of Materials Science and Engineering at NTNU, is figuring out how we can take advantage of the piezoelectric effect to make the next generation of biomedical implants.

From the left: Julia Glaum, Kara Poon, Mikalai Zhuk, Nikolai Gaukås, Magnus Rotan, missing Evgeniya Khomyakova. Photo: Per Henning/NTNU

Piezoelectric materials create an electric charge when you apply mechanical pressure to them. They are used in many situations, from a buzzer in your phone to the pickup on an electric guitar.

Our bones also display piezoelectric properties: If you press on a piece of bone, it creates an electric charge. "One of the theories is that bone uses these charges to know where and where not to grow, and how to heal when it's broken," says Glaum.

By creating implants made of piezoelectric materials, we could tell the bone where to grow. "If you could guide the bone cells to grow into the implant material, by providing these charges, you could make an implant that is stable for a longer time," she says.

These implants would also hopefully improve the healing process, and perhaps one day even become temporary stop-gaps instead of permanent fixtures.

This is a young and relatively unexplored research area, says Glaum, so these implants are not likely to be here any time soon. But her team is making headway with the basic science needed to lay the foundations.

One unexpected finding so far is a material that dissolves under the right conditions. "Some of the materials that we make, depending on how we make them, are either very stable in liquid environment or dissolve very fast," she says.

This wasn’t exactly what the team was looking for during the experiment in which they discovered this fast-dissolving material – but, now they’ve found it, Glaum can see the upside. They’ve since been able to make it break down over the course of a day, or keep it in one piece for “weeks and weeks”, simply by varying the way it is made.

“If you could tailor the time that it takes until it dissolves, it would just get replaced by human tissue,” she says. “That would be the ideal third-generation biomaterial.”

Kelly Oakes, June,2019