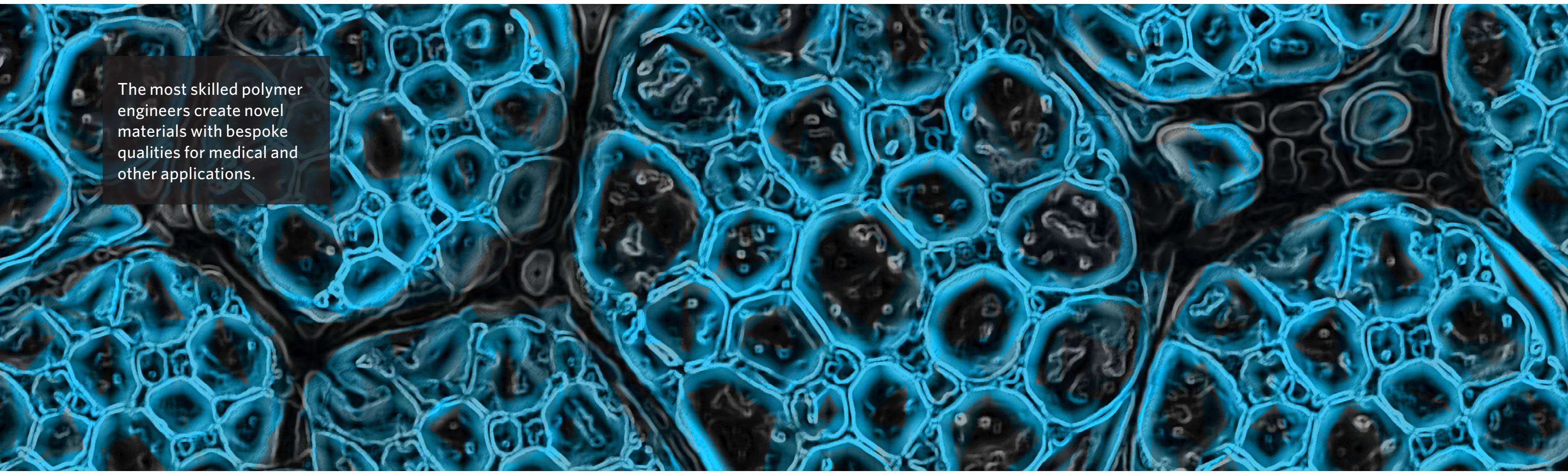

The most skilled polymer engineers create novel materials with bespoke qualities for medical and other applications.

Credit: GiroScience / Alamy

FROM BIODEGRADABLE SCREWS TO VITRIMERS: CHEMISTRY EXPERTS COLLABORATE

Polymer specialists from academia and industry are mixing organic and inorganic materials to tackle the anterior cruciate ligament and other tough repairs.

As a professor of biomaterials at Imperial College London, Julian Jones focuses on using the latest technology to solve healthcare problems. "The surgeons tell us what they need," he says. "As the engineers, we think about the material design."

Jones's colleagues in orthopaedics were frustrated by the one in ten failure rate for repairs of the anterior cruciate ligament (ACL). This connective tissue joins the thigh bone to the shinbone behind the kneecap and is often torn in sports like skiing or football.

Grafts to replace the ruptured ligament don't naturally integrate with the bone; surgeons use screws to hold the graft in place. Titanium screws will last, but can shred the graft over time, whereas biodegradable screws risk the graft detaching when the screws dissolve. By constructing a polymer-based biodegradable screw with the active properties of bioglass, a mineral-based substance that stimulates bone growth, Jones hopes to firmly integrate the graft and bone, so that they remain connected once the screw is gone.

The challenge is combining biocompatible polymers with bioglass. Jones's solution adds silica groups to the polymers, which can covalently bond with the bioglass. The two components, thus chemically linked, act as a single hybrid material that activates the bone. To make this hybrid material biodegradable, Jones attaches several short polymers to a biodegradable core, creating a dendrimer or star-shaped structure. When the core degrades, the polymers detach — and are small enough to pass through the kidneys.

Taking screws from the lab bench to the surgical theatre requires a polymer specialist who can manufacture at scale at medical-grade quality. Despite ACL tears being a common injury, the few grams of material needed for each screw means that overall quantities will be small — and of less interest to major multi-national manufacturers. So Jones looked for a small-to-medium sized company (SME).

Larger chemistry set

The right partner was organic chemistry manufacturer Makevale, headquartered in Ware, UK, with sites around the world. Makevale specializes in high-quality methacrylate polymers, which form the basis of Jones's hybrid materials. Makevale's size and technical capability means that it can act quickly on research output. "Even though the medical industry is worth billions, there are so many critical niche materials that need to be made," says Samit Ahir, CEO of Makevale.

Makevale's SME status is no hindrance to quality or quantity. "We have the infrastructure and experience to scale up these ideas into actual products," says Ahir. "As with any chemistry set, it's not enough to have a Bunsen burner and a distillation plant – you need everything in between, and we have all of that."

Makevale has other collaborations, including with Eugene Terentjev, professor of polymer physics at the University of Cambridge. Terentjev's team is developing novel vitrimers – plastics that can be repaired and reshaped when heated. There are many surprising applications of vitrimers, from phone screens to car bumpers, says Ahir. He adds that it's important to keep abreast of promising areas of materials research as they may lead to similar collaborations that need a versatile and skilled company. "Looking at what's coming out of the academic world is fundamental to Makevale's future." ■

Makevale

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