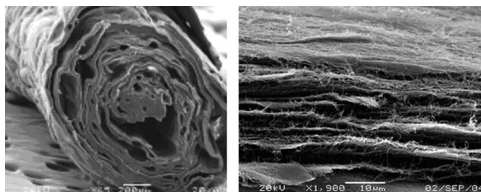


Tissue-like constructs made in minutes

BIOMATERIALS

Tissue engineering typically involves seeding a scaffold material with cells, then allowing the cells to grow in the laboratory and remodel the construct into a biologically functional tissue. This is a slow process that is expensive and difficult to control, and it has found limited success. Rather than rely on cells, UK researchers at University College London and Eastman Dental Institute have simply and rapidly engineered tissue-like constructs without waiting for cell participation [Brown *et al.*, *Adv. Funct. Mater.* (2005) **15** (11), 1762].

The starting point is hyperhydrated collagen gels seeded with human dermal fibroblasts. Collagen is a protein that acts as a structural support in a wide range of tissues including skin, bone, tendons, ligaments, cartilage, blood vessels, and nerves. The team discovered that a compressive load could rapidly expel liquid from the gels. Placing the gels on blotting paper and using a load of 50 g for 5 minutes reduces a 3.6 mm high gel into a sheet of ~30 μm thickness. Since the thin sheets are difficult to handle, the researchers rolled them up into tubes. This process can be extended to construct complex, heterogeneous three-dimensional structures with dimensions of 10–100 μm from the collagen sheets. Fine collagen lamellae are found throughout the compressed sheets and the process does not affect cell viability. In fact, the cells tend to line up along the collagen lamellae, assuming a tissue-like distribution and morphology. The break stress of the collagen sheets is 0.55 MPa, which is greater than conventional cell-seeded



Collagen sheet after being rolled into a tube (left) and multiple lamellae of collagen fibril networks within a sheet (right). (© 2005 Wiley-VCH.)

collagen gels even after being cultured for weeks. “The construct is shrunk to give micro- and nanoscale features with a biomimetic collagen fibrillar architecture, density, and mechanical strength in minutes,” says Robert A. Brown.

The researchers believe that fabrication of some collagen-based skin equivalents could become >200 times faster using their technique. They also suggest that drug release from native collagen gels would be improved through greater control of pore size and increased mechanical strength.

“This process is not necessarily limited to collagen, though this is by far the most important and useful scaffold material as it means the completed construct is close to being a natural biological tissue,” explains Brown. “The speed and engineering control which this provides suggests that we can now work toward the bedside fabrication of customized implants for patients,” he claims.

Jonathan Wood

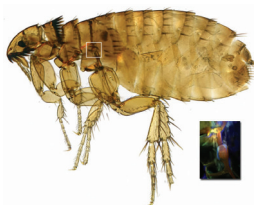
Insects jump to provide new rubber-like material

BIOMATERIALS

Resilin is an elastic protein related to elastin, gluten, and spider silks that is characterized by low stiffness, high strain, and efficient energy storage. It enables insects to fly and fleas to jump up to 200 times the length of their body.

Australian researchers have now transferred the first portion of the resilin gene from a fruit fly into *Escherichia coli* bacteria, enabling a soluble protein to be produced in the laboratory [Elvin *et al.*, *Nature* (2005) **437**, 999]. The team from the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the University of Queensland, and the Australian National University is then able to cast the protein into a rubber-like, high molecular weight biomaterial by rapid Ru(II)-mediated photocrosslinking.

“We believe that our work will greatly facilitate structural investigations into the functional properties of resilin and shed light on more general aspects of the structure of elastomeric proteins,” say the researchers.



Picture of a flea courtesy of Chris Elvin and CSIRO.

The resiliency of the samples (the ability to recover after deformation under an applied stress) was compared to their biological counterparts. A tendon from a dragonfly wing shows a resiliency of ~92% with negligible hysteresis upon compression. In comparison, the resiliency of lab-formed resilin samples varies between 90% and 92%, which is about 10% better than other high-resiliency synthetic polymers.

Patrick Cain

Single QDs detect DNA

NANOTECHNOLOGY

Improving the diagnosis of genetic disease requires new methods for the rapid and highly sensitive detection of DNA.

Tza-Huei Wang and colleagues at The Johns Hopkins University have developed a quantum dot (QD)-based sensor that produces a distinct signal on binding just 50 copies of DNA or less [Zhang *et al.*, *Nat. Mater.* (2005) doi: 10.1038/nmat1508].

The sensor consists of a CdSe-ZnS core-shell QD decorated with streptavidin molecules and two short, single-stranded DNA probes, one with a fluorescent dye attached and the other labeled with biotin. The probes are designed to bind to opposite ends of a target DNA molecule. When the target DNA is present, the two probes assemble on the target and bind the QD through biotin-streptavidin links. This brings the fluorescent dye into proximity with the QD.

The team uses a laser that excites the fluorescence of the QDs but not the dye on the free DNA probes. Without any target DNA, only QD fluorescence is observed. When target DNA is present, the proximity of the dye and QD in the QD-DNA assembly allows fluorescence resonance energy transfer (FRET) to occur and emission from the dye is observed.

Many target DNA molecules are concentrated at the surface of the QD, giving an increased signal. As a result, the current detection limit is already ~100 times better than conventional FRET-based assays.

The Johns Hopkins researchers have demonstrated the potential of their QD sensor system for diagnosis. In combination with a standard assay, they used the sensor to detect DNA point mutations in clinical samples from patients with a type of ovarian cancer.

“The ultrahigh sensitivity and accuracy of this QD nanosensor makes it an ideal tool for diagnosis of disease at an early stage,” says Tza-Huei Wang.

Jonathan Wood