Imperial College London

Biomimetic Osteochondral Scaffold

A novel multi-zonal anisotropic osteochondral scaffold has been developed which mimics the natural structure of articular cartilage with zone specific mechanical and biological properties. This innovative scaffold material not only provides the mechanical strength to support load-bearing but also assists with new extracellular matrix formation enabling replacement of the natural tissue. An *in vivo* study in skeletally mature pigs has been conducted to test the performance of the scaffold.

Proposed use

- Focal chondral and osteochondral lesions
- Conjunction use with microfracture
- Scaffold for *in vitro* tissue engineering
- Fused with an osteo component for osteochondral repair

Problem addressed

Articular cartilage damage or deterioration can be caused by injury or trauma, congenital abnormalities or hormonal disorders. Ankle, digits, elbow, hip, knee, shoulder or wrist can be affected by articular cartilage disorders. If damaged cartilage is not treated, it can worsen and eventually require joint replacement surgery.

However, articular cartilage is a difficult tissue to mimic because it is a highly organized, fibre-reinforced tissue with specific mechanical and biological properties. A tissue construct must mimic the anisotropic mechanical properties and structural organization.

Technology overview

A team led by Prof Molly Stevens developed the Osteochondral Scaffold. The 3D fibrous scaffold structurally mimics articular cartilage. It supports cell infiltration, proliferation and the generation of cartilage-like tissue. Importantly, its structural orientation varies throughout the depth of the scaffold: parallel, random and perpendicular alignment, which follows the zonal organization of articular cartilage. It also provides a template to organize the newly deposited matrix. The scaffold is a 3D laminated construct comprising various nano to micron-sized structural features giving it an anisotropic structure and composition.

Benefits

- Biomimetic composition with layers of varying fibre orientation, pore structure, and stiffness to closely align with natural cartilage
- Material can be used to repair larger defects, as the material is capable of bearing dynamic load while supporting tissue growth
- Mechanical properties provide a protective environment for the cells migrating or seeded into the scaffold
- The scaffold features high cellular seeding efficiency and with the ability to localize cell number within different regions of the scaffold
- The scaffold supports long term production of cartilage like tissue as established through extensive *in vitro* characterization
- Scaffold can be integrated with a number of bone substitutes

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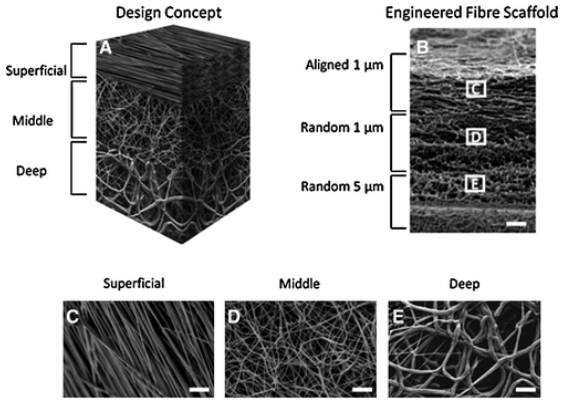

Zonal fiber mechanical properties can be fabricated by the proposed technology in a continuous scaffold. The diagram (A) illustrates the zonal placement of varying fiber zones and the resultant electron microscopy images of the bulk anisotropic scaffold (B) and the varying fibers of aligned (C), randomly oriented (D), or randomly oriented fibers throughout the scaffold (E). Scale bar = 100 µm in (B); 10 µm in (C–E).

Intellectual property information

US9393097B2 LAYERED FIRBROUS CONSTRUCT

Inventor information

Dr Molly Stevens

Professor of Biomedical Materials & Regenerative Medicine in the Faculty of Engineering, Department of Materials at Imperial College London. She was recognised by The Times as one of the top ten scientists under the age of 40 and also received various awards.