General public abstract:

Treating severe tissue defects is a major challenge in medicine and bioengineering. A promising approach involves using tissue engineering (TE) scaffolds, which have porous structures that help cells grow. Recent breakthroughs in 3D printing have greatly improved scaffold design, allowing for precise and complex structures. One innovative method is melt electro writing (MEW), which creates detailed, regular porous designs consisting of straight fibers. Polycaprolactone (PCL) remains the most widely utilized polymer for MEW applications. Its biodegradable nature, non-toxicity, and biocompatibility make it a popular choice for the fabrication of TE scaffolds

Interestingly, fibers created by MEW sometimes form coils, initially thought to be a fabrication error. Later, it was shown that MEW structures with coiled fibers could be used as advanced TE scaffolds providing hierarchically organized porosity.

The idea of using different pore sizes in TE scaffolds is based on the principle that small pores help cells attach, while larger pores allow new tissue to grow.

Another known method providing additional porosity level to 3D printed scaffolds is by combining melt extrusion with a technique called ‘porogen leaching’. In this technique fibers are printed from polymer blend composed of PCL and polyethylene glycol (PEG), which plays the role of ‘porogen’. The porogen is then dissolved or "leached" out of the mixture using a solvent like water. As the porogen dissolves, it leaves behind tiny holes or pores on the fiber’s surface.

The planned study aims to create multi-level hierarchically ordered TE scaffolds with entangled fibers by combining MEW and porogen leaching, using PEG as the porogen. The research will explore how different fabrication settings affect the scaffold's structure, strength, and ability to support tissue regeneration.

This approach showcases the potential of advanced scaffold fabrication techniques to create versatile, structured designs that improve laboratory models and treatment options for severe tissue damage. Novel multi-level hierarchical MEW scaffolds have potential to revolutionize TE, offering customizable solutions for tissue regeneration.