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STIMULI RESPONSIVE NANOCOMPOSITES BASED ON CELLULOSE NANOCRYSTALS

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Cellulose nanocrystals (CNCs) are high-aspect ratio, mechanically stiff fibers which can serve as both a bio-renewable reinforcing agent in nanocomposites, as well as a handle for adding stimuli responsiveness. CNCs can be extracted from a wide range of natural cellulosic materials, with characteristics such as crystal structure, crystallinity and aspect ratio fluctuate widely between sources. Here, we report small molecule functionalized cellulose prepared for sustained delivery in a variety of environments. Moieties attached to the surface of cellulose nanocrystals show that both irreversible and reversible changes can be induced by application of an external stimuli.

Moreover, we present the case of articular cartilage, which serves as a low-friction cushion in synovial joints and is vital for mammalian skeletal movements. Due to its avascular nature and the low cell density, the tissue has a limited ability to regenerate, and damage due to injury, wear and tear, or disease usually requires surgical intervention. While articular cartilage had been predicted to be one of the first tissues to be successfully engineered, it proved to be challenging to reproduce the complex architecture and biomechanical properties of the native tissue. Here we report the fabrication of multi-layer polymer nanocomposite scaffolds that mimic the structural design, chemical cues, and mechanical characteristics of mature articular cartilage. These scaffolds guide the morphology, orientation, and phenotypic state of cultured chondrocytes in a spatially controlled manner, support the growth of tissue with features that are reminiscent of the natural analogue, and promote localized hydroxyapatite formation to permit integration with the subchondral bone.

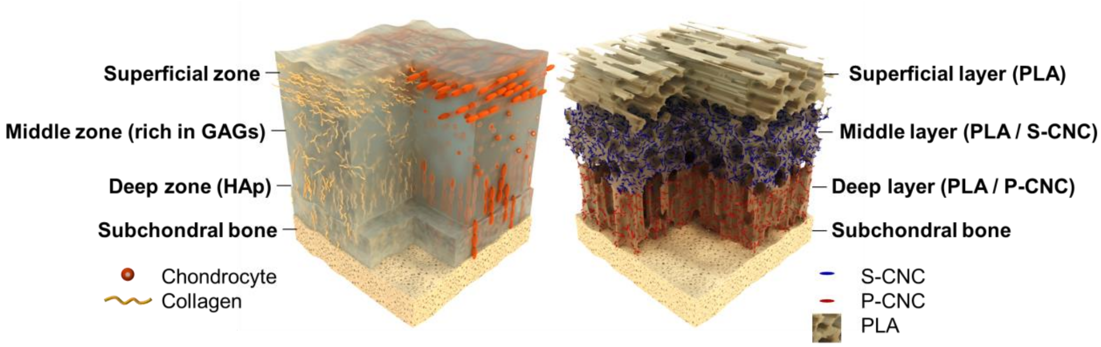

Figure 1. Architecture of mature articular cartilage and the multi-layer polymer nanocomposite scaffolds studied.