

Layered Magnetic Hydrogels for Cell Placement via Time-dependent Field Self-Assembly

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The design of hydrogel-based artificial tissues capable of reversible, programmed, and complex motions requires both stimuli-responsiveness and structural anisotropy. In this work, we achieve non-unidirectional anisotropies by structuring biocompatible hydrogels into lamellar architectures using particle suspensions. The method involves the application of an unsteady magnetic field to a static sample [1]. In this approach, magnetic particles undergo directed self-assembly within a polymer matrix that subsequently gels over time, effectively "freezing" the formed structures. We analyze the aggregation kinetics, characterize the resulting lamellar patterns, and construct phase diagrams for the available microstructure [2]. Crucially, we demonstrate that the resulting layered structures are capable of confining human fibroblast cells between adjacent particle-rich layers, highlighting the potential of these architectures for guiding cell positioning. The morphology and periodicity of the lamellae are shown to depend sensitively on particle concentration and geometric confinement. These findings pave the way for the development of advanced anisotropic hydrogels with programmable internal architectures, enabling applications in soft robotics, bioactuation, and tissue engineering.

Keywords:

Anisotropic hydrogel, magnetic hydrogel, magnetorheological fluid, lamella, layer, pattern, tissue engineering.

References:

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