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Morphing hard and soft matter by reaction-transport dynamics

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Engineering next-generation materials that can grow into efficient multitasking agents, move rapidly, or discern environmental cues greatly benefits from inspiration from biological systems. In the first part of my talk, I will present a geometrical theory that explains the biomineralization-inspired growth and form of carbonate-silica microarchitectures in a dynamic reaction-diffusion system. The theory predicts new self-assembly pathways of intricate morphologies and thereby guides the synthesis of light-guiding optical structures. The second part is dedicated to a soft matter analog of controlled actuation and complex sensing in living systems. Specifically, I will introduce a continuum framework of a simple hydrogel system that is activated upon transport and reaction of chemical stimuli. The hydrogel exhibits unique cascades of mechanical and optical responses, suggesting that common gels have a much larger sensing space than currently employed. The theoretical work presented here is intimately connected to modern materials science. The effective convergence of theory and experiment paves the way for optimized hard or soft biomimetic materials for applications ranging from bottom-up manufacturing to soft robotics.