

Evolving Materials

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Material design, discovery, and fabrication approaches are typically based on exploring large parameter spaces, empirically or with theoretical guidance, or on targeted fabrications if design principles and methods for realization exist. In contrast to abiotic materials, biological organisms solve the challenge of finding the “good enough” solution through diversification of approaches, selection of best performers, and their mutation toward improvement through selection and adaptation. We propose establishing design principles and experimental approaches for enabling materials evolution processes in DNA-programmable systems with functional nano-cargo. Our strategy involves the development of inverse design approaches for materials with a clearly defined correlation between material genotype, a set of bonds required for uniquely defined structure assembly, and material phenotype, the resulting structural morphology and functional performance. The approach aims to establish methods for realizing a guided evolution of materials, where a genotype of the best performers can be stored as a physical nanoscale memory for the consequent guided mutation towards improved performance. We will apply this material evolution strategy to create novel mechanical, chemically-active, and optical metamaterials.