Programmable CRISPR-Responsive Smart Materials

Technology #21161

Applications

This technology is a programmable, stimuli-responsive biomaterial with broad applications in medicine and biotechnology, including tissue engineering, molecular diagnostics, environmental monitoring, bioelectronics, and microfluidics.

Problem Addressed

Stimuli-responsive materials are highly attractive in medicine and tissue engineering, due to their ability to modulate their chemical and mechanical properties in response to environmental cues. In particular, hydrogels that respond to DNA in the environment have emerged as useful biomaterials, such as for detection of pathogens or disease-causing mutations. However, current DNA-responsive hydrogels are not easily adaptable for detection of new nucleotide sequences, and require high concentrations of the DNA stimulus, greatly constraining the programmability of these biomaterials. To address these issues, the inventors have utilized the CRISPR-Cas system to develop a highly programmable and versatile DNA-responsive hydrogel.

Technology

This technology is a programmable, CRISPR-based hydrogel with a wide range of abilities, including release of biomolecules or regulation of electric circuits, in response to specific DNA targets. The hydrogel is constructed using single-stranded DNA sequences as key structural elements or as linkers to cargo, such as fluorescent molecules. Following introduction of a user-defined, external DNA stimuli, a Cas enzyme and guide RNA (gRNA) complex cleaves the single-stranded DNA sequences in the hydrogel, leading to the restructuring of the polymeric material or release of the bound cargo. Importantly, this technology eliminates the need to encode target-sequence specificity into the gel structure. Instead, specificity of the Cas enzyme is easily modulated through simple replacement of the gRNA sequence. The inventors have demonstrated that a wide range of different payloads, including fluorescent molecules, active enzymes, and encapsulated nanoparticles and live cells, can be released from hydrogels at a controllable rate upon exposure to low concentrations of DNA stimuli. Furthermore, this smart biomaterial can act as a stimuli-responsive electric fuse and a controllable valve in fluidic devices.

Advantages

- DNA stimuli-responsive hydrogel that leverages the specificity and programmability of the CRISPR-Cas system
- Target specificity is easily modulated through simple replacement of the guide RNA sequence
- Low concentrations of DNA stimulus are required to induce response
- Demonstrated uses for this versatile technology include controlled release of bound payloads (e.g., fluorescent molecules, active enzymes, nanoparticles, or live cells), degradable electrical fuses, and valves in fluidic devices

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- Wide range of applications in medicine, tissue engineering, bioelectronics, and environmental monitoring

Intellectual Property

IP Type: Pending PCT Application

IP Title: DNA-responsive hydrogels, methods of altering a property of a hydrogel, and applications thereof

IP Number: WO 2020-197634

IP Type: Pending US Patent Application

IP Title: DNA-responsive hydrogels, methods of altering a property of a hydrogel, and applications thereof

IP Number: US 2020-0308577

Categories For This Invention:

Materials
Life Sciences
Biomaterials
Biotechnology
Clinical Applications
Tissue Engineering
Diagnostics
Gene
Microfluidics (Diagnostics)
Environment
Sensing
Imaging
Research Tools
DNA
Microfluidics (Research Tools)
RNA
Screening Assays
Therapeutics
Drug Delivery

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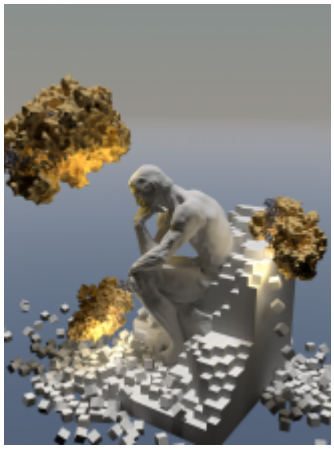
Publications:

Programmable CRISPR-responsive smart materials
Science
August 23, 2019, 365 (6455), p. 780-785

External Links:

Collins Lab
https://collinslab.mit.edu/

Image Gallery:



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