UNIVERSITÄT HEIDELBERG
ZUKUNFT SEIT 1386

Biohybrid Hydrogel System Having Actuator Cells

Technology Offer

Ref. No.: 1024-21

Category

Bio Engineering

Keywords

Biohybrid Actuation

Soft Robotics

Adaptive smart Material

Development stage

Prototype

Seeking

Licensee

IP status

Patent pending

Background

Soft robotics is an emerging field aiming to enable safe and adaptive interaction with complex environments through compliant materials. Compared to rigid robotic systems, soft actuators offer significant advantages in applications such as minimally invasive surgery, rehabilitation, and bioinspired gripping.

However, a key challenge lies in the development of suitable actuation mechanisms. Conventional systems often rely on pneumatic or hydraulic components, which require complex external equipment and offer limited efficiency and controllability. Biohybrid approaches using living cells, such as muscle cells, promise natural and energy efficient actuation but still suffer from limited controllability and structural stability.

Thus, current technologies lack an integrated solution that combines precise control of biological actuators with dynamically tunable mechanical properties of the surrounding material. The present invention addresses this gap by introducing a novel biohybrid material system.

Technology

The invention relates to a biohybrid hydrogel system that integrates living actuator cells, particularly muscle cells, into a functionalized polymer matrix. This approach combines the adaptability of synthetic materials with the active force generation of biological systems.

A key feature of the technology is the ability to dynamically tune the mechanical properties of the hydrogel, such as stiffness, in response to external stimuli (e.g. chemical, physical, or optical signals). These changes directly influence the behavior of the embedded cells, enabling controlled contraction and movement.

The system forms a tightly coupled interaction between the hydrogel as a structural and tunable matrix, the cells as active actuators and external stimuli as control inputs.

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This enables spatially resolved and reversible control of actuation, while maintaining a biomimetic environment that supports cell viability and function.

The technology opens up applications in soft robotics, adaptive materials, biomedical devices, and tissue engineering, representing a significant step toward functional, living material systems.

Benefits

- Adaptive material behavior
- Integrated actuation
- Precise control mechanism
- Versatile platform technology

Applications

- Soft Robotics
- Biomedical Devices & Implants
- Tissue Engineering
- Organ on a Chip Systems

Publications

- Appiah, C., Arndt, C., Siemsen, K., Heitmann, A., Staubitz, A., & Selhuber-Unkel, C. (2019). Living materials herald a new era in soft robotics. *Advanced Materials*, *31*(36), 1807747.

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