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Tumbling Microrobots for in vivo Targeted Drug Delivery

3D-printed µTUMs that navigate the GI tract and release drugs on-demand via temperature-triggered seals.

Researchers at Purdue University developed innovative 3D-printed tumbling magnetic microrobots (ÂµTUMs) designed for in vivo targeted drug delivery in the large intestine. These microrobots, fabricated via high-resolution stereolithography, integrate permanent micro-magnets for magnetic actuation and feature hollow cavities to carry drug payloads. Controlled drug release is achieved using a thermally sensitive wax seal, optimized to melt between 38Â°Câ€“42Â°C, allowing precise payload release via localized heating such as focused ultrasound. Locomotion performance was validated in vitro, in phantom, and in vivo environments, demonstrating robust navigation and effective temperature-triggered drug delivery. The ÂµTUMs were also shown to be biocompatible, supporting their potential for minimally invasive and highly targeted therapeutic applications in gastrointestinal healthcare.

The 3D-printed ÂµTUM microrobots were validated through a series of locomotion and drug release tests conducted in vitro (on flat substrates), in phantom (a rat colon model made of gelatin), and in vivo (within live rat colons). Locomotion performance was measured across varying magnetic frequencies and environments, showing consistent movement and slope-climbing ability. Drug release was tested using a fluorescent protein and wax-coated payload, demonstrating controlled release triggered by temperature increases via a hotplate or focused ultrasound. Biocompatibility was confirmed through cell viability and proliferation assays using murine fibroblasts.

Advantages:

Â· Controlled, on-demand release

Â· Increased payload capacity

Â· Biocompatible materials

Technology ID

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Category

Robotics & Automation/Automation & Control

Pharmaceuticals/Computational Drug Delivery & Nanomedicine

Digital Health & Medtech/Implantable Medical Devices

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View online

Â· Minimally invasive navigation

Applications:

Â· Colorectal disease treatment

Â· Delivery of biologics in the GI tract

Â· Ultrasound-guided therapeutic interventions

TRL: 5

Intellectual Property:

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