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Advancements in Light-driven Lattice Soft Microrobots with Multimodal Locomotion

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INTRODUCTION

Light-driven lattice soft microrobots with multimodal locomotion represent a significant advancement in the field of soft robotics, enabling the creation of small-scale robots that can move and perform tasks in response to light stimuli. These robots, typically made from soft, flexible materials like hydrogels or elastomers, are designed to harness the power of light to induce movement. Unlike traditional rigid robots, soft microrobots can deform and adapt their shape in response to external forces, making them ideal for applications in confined or delicate environments, such as inside the human body or in microscale manufacturing processes. One of the most remarkable features of these microrobots is their ability to exhibit multimodal locomotion. Traditional robots, whether soft or rigid, often rely on a single mode of movement, such as crawling, walking, or swimming. However, light-driven lattice soft microrobots are designed to switch between different locomotion modes depending on the applied light pattern, intensity, or wavelength. This multimodal ability is achieved through the careful design of the robot's lattice structure, which can be programmed to respond to light in multiple ways, enabling it to move in diverse directions or even change its movement pattern to suit specific tasks.

DESCRIPTION

The mechanism behind this multimodal locomotion involves the material properties and the geometry of the microrobot. Light is typically used to trigger photothermal or photochemical reactions in the materials, leading to localized heating or chemical changes. These reactions cause parts of the soft robot to expand or contract, creating movement. The lattice structure of the robot plays a crucial role in controlling the movement, as it allows the robot to deform in a controlled and predictable manner. By modulating the intensity or direction of the light, the lattice microrobot can switch between different movement modes, such as walking, rolling, or even swimming through a liquid medium. One example of how light-driven lattice soft microrobots operate is by using photothermal materials, which absorb light and convert it into heat. This localized heating induces thermal expansion in specific regions of the robot, causing it to bend or twist. The lattice structure, which may consist of interconnected soft materials, allows for precise control over how the robot bends, enabling different types of motion. In some designs, multiple light sources or varying wavelengths are used to create complex patterns of heating, leading to sophisticated movement behaviors. For instance, by shining light from different directions or using alternating light pulses, the robot can perform a coordinated motion sequence or shift between different locomotion modes. The advantages of light-driven lattice soft microrobots with multimodal locomotion extend beyond their versatility in movement. Their small size and soft materials make them well-suited for applications that require delicate handling, such as medical procedures, environmental monitoring, or microscale assembly tasks. In medical applications, these robots could be used for targeted drug delivery, minimally invasive surgeries, or diagnostics, where their ability to navigate through small and complex environments, such as blood vessels or tissues, would be invaluable. In such applications, the robots could be designed to respond to specific wavelengths of light, allowing for precise control over their movement and operation [1-4].

CONCLUSION

In conclusion, light-driven lattice soft microrobots with multimodal locomotion are at the forefront of soft robotics, offering new possibilities for precise, adaptable, and efficient movement in a variety of applications. Their ability to switch between different modes of locomotion in response to light stimuli makes them

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highly versatile, while their small size and soft materials enable them to navigate delicate and confined spaces. With continued research and development, these robots hold great promise for advancing fields such as medicine, environmental monitoring, and microscale manufacturing, pushing the boundaries of what soft robotics can achieve.

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CONFLICT OF INTEREST

The author declares there is no conflict of interest in publishing this article.

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