Towards the Next Generation of Biomedical Devices using Advanced 3D Printing Technologies

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Résumé :

In recent decades, 3D printing has undergone remarkable advancements both in technology and materials. However, a significant limitation of most 3D printable materials is their static nature, unable to respond or adapt to changes in their environment. This restricts their applicability in smart technologies requiring dynamic behavior. To address this challenge, the concept of "4D printing" has emerged, where time is integrated as a fourth dimension into 3D geometries, enabling new functionalities such as responsiveness and adaptivity to external stimuli. Among various fabrication methods at the microscopic scale, two-photon polymerization (TPP) has emerged as a well-established technique for creating intricate micro-objects with stimuli-responsive surface properties and high resolution[1].

In this work, we develop microstructures capable of dynamic movement by leveraging specific processes and materials. Our focus is on custom programming these structures at the micrometer scale. Liquid crystals (LCs)[2], known for their optical properties and responsiveness to external stimuli, serve as the ideal material[3]. We fabricate objects with precisely controlled orientation, enabling both thermal and photo actuation. To realize this, we introduce a novel method and tailored LC resins compatible with 3D microfabrication via TPP. This technique solidifies the nematic phase orientation during fabrication, ensuring precise three-dimensional control of LC molecular alignment (see Figure 1).

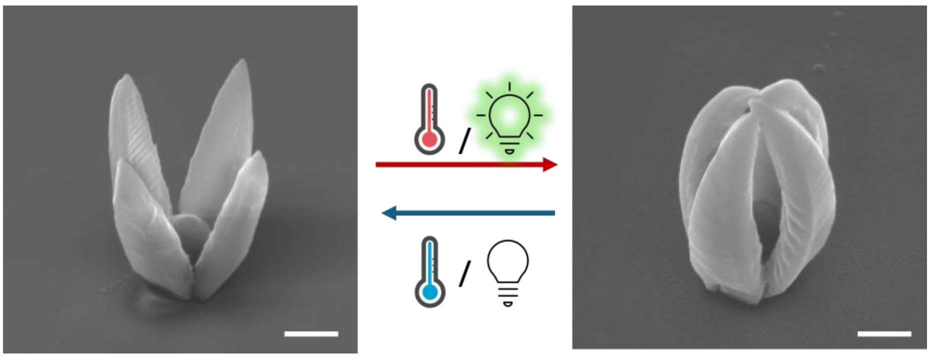

Figure 1. SEM images of 3D printed programmable LC clamp structure in A) open form at room temperature and B) closed form at 200 °C upon heating or upon irradiation of 532 nm green light. Scale bar: 30 µm.

Références :

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