**Solid Freeform Fabrication of a Conceptual Artificial Photosynthesis Device**

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**Introduction**

We designed an artificial photosynthesis device and fabricated the porous structure of this device. This device can absorb light energy to synthesize organic compounds. In order to constrain reaction solutions in a solid structure and increase the reaction efficiency, we built this device using porous chitosan scaffold with interconnected micro-channels using a heterogeneous 3D rapid prototyping machine followed by liquid nitrogen freeze-drying. The fabricated device can be integrated into an artificial photosynthesis board, which includes microfluidic chips, integrated sensors and digital circuits.

**Artificial photosynthesis multilayer device**

The figure below illustrates a leaf/tree-like example of the device, although it can be designed and manufactured in any shape. In order to simplify final product separation, the branches/channels of the leaf will be connected to a chromatographic column which contains the gel for glucose-size molecule isolation.

**Artificial photosynthesis board**

The artificial photosynthesis system includes a photoreaction board (a), filtration device (b), a product harvest and an organic reaction solutions recycling unit (c) to generate and control the desired biofuel systematically and automatically. The photoreaction board includes multiple photoreaction units (d), which can perform light reaction and dark reaction individually. Each single device contains a fluid inlet-outlet, a porous chitosan layer, and filtration.

**Heterogeneous materials printing**

Our rapid prototyping machine can perform heterogeneous 3D building with high viscous fluidic materials. The chitosan scaffold with channels was printed by pre-loaded G-code. After building the whole micro channels structure, we generated micro-size porous structure for dark reaction by lyophilization.

**Summary**

The heterogeneous printing followed by lyophilization can generate porous chitosan scaffold with interconnected channels which support the reaction solutions in this novel artificial photosynthesis device. The artificial photosynthesis board provides a platform for multiple photosynthesis devices, which are integrated with sensors and integrated circuits.

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