Materials Manufactured from 3D Printed Synthetic Biology Arrays

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The Problem
Many complex, biologically-derived materials have extremely useful properties (think wood or silk), but are unsuitable for space-related applications due to production, manufacturing, or processing limitations. Large-scale ecosystem-based production, such as raising and harvesting trees for wood, is impractical in a self-contained habitat such as a space station or potential Mars colony. Manufacturing requirements, such as the specialized equipment needed to harvest and process cotton, add too much upmass for current launch technology.

The Vision
Cells in nature are already highly specialized for making complex biological materials on a micro scale. We envision combining these strengths with the recently emergent technologies of synthetic biology and 3D printing to create 3D-structured arrays of cells that are bioengineered to secrete different materials in a specified three-dimensional pattern.

Applications
* Manufacturing of biological materials, ranging from construction materials to foodstuffs, from small stocks of cells and a basic palette of local resources.
* Creation of microstructured materials, such as honeycomb-grained wood, out of materials previously unworkable at that scale.
* Synthesis of new and novel biocomposites, such as reinforced silk, that were previously impossible.

Potential Impact
If successful, this application would dramatically expand manufacturing capabilities both on Earth and in space:

In situ resource utilization. The ability to make a far greater range of materials and products out of the limited basic resource palette offered by existing in situ resource extraction techniques makes the dream of an off-world habitat closer to reality.

Reduced equipment and material upmass. Production of a wide variety of ready-to-use highly specialized materials with low labor cost and starting mass gives greater range and flexibility to all space missions.

Structured biomaterial production. New ready-to-use macro-, micro-, and molecular manufacturing techniques for traditional materials such as wood, reduce cost and enable new, innovative products.

New and novel biocomposite creation. The ability to create completely novel material composites from any base material that cells can be engineered to produce opens up a new frontier in materials design and manufacturing.

The Study
We are using a custom microdispensing setup to deposit two types of cells, which in turn will form a 2D, two-material grid, as a proof-of-concept.