Improving Satellite Compatible Microdevices to Study Biology in Space

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The technology for biology in space lags far behind the gold standard for biological experiments on Earth. To remedy this disparity, the Rothschild lab works on proof of concept, prototyping, and developing of new sensors and devices to further the capabilities of biology research on satellites.

One such device is the PowerCell Payload System. One goal for synthetic biology in aiding space travel and colonization is to genetically engineer living cells to produce biochemicals in space. However, such farming in space presupposes bacteria retain their functionality post-launch, bombarded by radiation, and without the 1G of Earth. Our questions is, does a co-culture of cyanobacteria and protein-synthesizing bacteria produce Earth-like yields of target proteins? Is the yield sensitive to variable gravitational forces? To answer these questions, a PowerCell Payload System will spend 1 year aboard the German Aerospace Center's Euglena and Combined Regenerative Organic-food Production In Space (Eu:CROPIS) mission satellite. The PowerCell system is a pair of two 48-well microfluidic cards, each well seeded with bacteria. The system integrates fluidic, thermal, optical, electronic, and control systems to germinate bacteria spores, then measure the protein synthesized for comparison to parallel experiments conducted on the Earth.

In developing the PowerCell Payload, we gained insight into the shortcomings of biology experiments on satellites. To address these issues, we have started three new prototyping projects: 1) The development of an extremely stable and radiation resistant cell-free system, allowing for the construction of proteins utilizing only cell components instead of living cells. This can be lyophilized on a substrate, like paper. (2) Using paper as a microfluidic platform that is flexible, stable, cheap, and wicking. The capillary action eliminates the need for pumps, reducing volume, mass, and potential failing points. Electrodes can be printed on the paper to sense for biochemicals. (3) Developing a modular, semi-autonomous microfluidic device that can be easily adapted for a variety of common biological experiments. This versatility will allow for quicker and cheaper experimentation.

These improvements to satellite experiment platforms have the potential to radically increase the return from NASA's biological and field studies with reduced development time, mass, and cost with increased robustness data and interpretation.