Synthesizing an Artificial Biological Leaf Capable of Evolving Oxygen via Photosynthesis

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Imagine a world where oxygen availability is not tied to fertile soil or oxygen tanks. The purpose of this project was to design an artificial leaf that can evolve oxygen via photosynthesis by embedding photosynthesizing cyanobacteria into a nanomesh. Such a device could eventually be developed to enable long-term space travel and extraterrestrial colonization. A cytocompatible polymer solution composed of poly(ethylene oxide), sodium alginate, and pluronic f-127 was created in order to make nanomeshes as support structures for the cyanobacteria. Nanomeshes with cyanobacteria, termed “artificial leaves,” had their oxygen evolution measured in sealed chambers using oxygen gas probes. These values were compared with those of control specimens. After the oxygen evolution trials, the artificial leaves were sputter coated and imaged under an SEM to test mesh characteristics, the porosity and average fiber diameter. The tensile strengths of the meshes were tested as a measure of strength and durability. Different ratios of PEO and SA were used for the different trial types, but the other electrospinning parameters - voltage, collector distance, flow rate, and relative humidity - were kept constant. After statistical analysis, it can be concluded that only one variety of the artificial leaves – a nanomesh composed of 75% PEO and 25% SA – outperformed the control specimens. It was initially predicted that this nanomesh would outperform the controls by exposing more surface area of the cyanobacteria, however, this has proven only partially true. Fiber optics and lensing likely also played a role in increasing the photosynthesis of the artificial leaves. This prototype serves as a model for future artificial leaf technology.

Awards Won:

Sigma Xi, The Scientific Research Honor Society: Second Award of $1,000

United States Steel Corporation: Second Place Award of $1,000