HEXA Leaf: Designing a Biologically Inspired Artificial Leaf Capable of Capturing and Transforming Carbon Dioxide Emissions and Sequestering Airborne Pollutants via Photosynthetic Oxygen Evolution and Phytotransformation

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In 2014 alone, 39.8 billion tons of CO2 were emitted globally, invoking fears of an intensification of the greenhouse gas effect and the propagation of pollution in large cities. As such, the sequestration and transformation of CO2 and organic pollutants via solar-powered production based on a process that mimics natural photosynthesis is of fundamental and practical interest. HEXA Leaf proposes a biologically inspired, artificial oxygen evolution and phytotransformation scheme that functions via a light-capturing nanoparticle array and multi-layer diffusion apparatus to sequester harmful pollutants and carbon dioxide in a variety of environments and then transform them into oxygen and glucose. The primary step of the apparatus involves the absorption of ultraviolet-light by a photosensitized Titania nanotube array, its conversion into spatially separated electron-hole pairs and the photocatalytic decomposition of rain-water into a hydrogen ion and molecular oxygen via electro-evolving catalysts made from a nickel and chromium. The secondary step involves the sequestering of CO2 in turbo-fans and its recombination with hydrogen on a fibroin-chloroplast membrane capable of driving the fixation of CO2 to synthesize glucose. Tests involving the placement of the apparatus in a carbon dioxide-rich environment indicate the sequestration and transformation of 82.5% of the present CO2 in under 5 minutes and under 1 sun illumination. Further feasibility studies in aircraft and power-plant simulations indicate the capacity of HEXA leaf to be an inexpensive, maintenance free and highly scalable solar-to-fuels system that employs low-cost manufacturing to efficiently curb CO2 emissions, filter airborne pollutants and provide natural ventilation in a wide range of environments.

Awards Won:

Third Award of $1,000