

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