# An "Artificial Leaf" That Can Generate Oxygen and Electricity

Chang, Sheng-Chun (School: Northfield Mount Hermon School)

Oxygen is essential for all lives on earth. It generally takes too long for seedlings to mature enough to produce significant oxygen through photosynthesis. Meanwhile, portable electricity is crucial for everyday human activities, but chemical batteries can be environmentally unfriendly. To mediate both problems simultaneously, we proposed to develop an artificial leaf using chlorella that can rapidly produce oxygen and electricity at a low cost. We used chlorella, a type of single-cell algae, as the photosynthetic element in the artificial leaf. Sodium alginate was combined with either calcium or barium chloride to form a hydrogel matrix for the chlorella-based artificial leaf. Different metals, including zinc, copper, aluminum, and magnesium, were tested for maximum voltage generation in various combinations. Our experiments showed that 2.0% sodium alginate and 5.0% barium chloride hydrogel had the best water retention and air permeability properties, making it most suitable as the substrate for the artificial leaf. When chlorella was combined with this substrate, the oxygen output reached 10.87 ± 0.56 mg/L, 98.9% of the maximum production after six hours (N = 3). The recorded maximum voltage of one piece of the artificial leaf containing copper and magnesium metals conductors was 1.285 ± 0.13 volts (N = 3). This study demonstrated the feasibility of producing a low-cost chlorella-based artificial leaf that generated electricity comparable to an AA battery, suggesting its potential to power a simple device. Future experiments will optimize chlorella density in the substrate matrix for maximum oxygen and electricity production.

**Awards Won:**

American Chemical Society: First Award of $4,000