Towards Solar Fuels: Using Laccases as Catalysts to Evolve Oxygen from Water

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Laccases are multicopper enzymes that are naturally evolved to catalyze the interconversion between oxygen and water; such a catalyst is in demand to solve the world's energy problems. Solar energy can be harnessed but must be stored in order to beat the diurnal cycle. Storing energy in a chemical format eases transport and minimizes waste. Artificial photosynthesis schemes are often visualized as modular . The core harvests light and uses the energy to separate electrons and positively charged electron holes. The high energy electrons are utilized at the cathode, where they are used to reductively generate fuel, such as hydrogen or methanol. The redox cycle is completed by replacing those electrons through an oxidation reaction at the anode. Each of these chemical reactions requires a catalyst so that little energy is wasted and they occur quickly. While the pros and cons of several chemical fuels, and thus cathodes, are currently being considered, one thing is certain: no matter what fuel is chosen, to be useful, oxygen will be evolved at the anode. Oxygen consumed during fuel use should be replaced and it must be made from water because water is the only economically affordable source. We are focusing on mutating laccases to improve their performance in these reactions.

We have:

- made a laccase resistant to boiling.
- made several single mutants that raise the Type-1 site reduction potential by ~60 mV.
- made several mutants that react 100x faster than wild type.
- measured the rate of intramolecular electron transfer by steady-state kinetics.