Searching for a semiconducting material that can efficiently photoelectrolyze water: the SHArK (Solar Hydrogen Activity Research Kit) project

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An economy based on solar-generated hydrogen as the energy carrier is sustainable, pollution free and the raw materials (sunlight and water) are available to all. Our research has focused on discovering a multiple-metal oxide semiconductor that can efficiently photoelectrolyze water into hydrogen and oxygen using only sunlight. The incredible number of possible combinations of metals, coupled with the lack of a theoretical model for predicting the photoelectrochemical properties of even ternary (3) metal oxides, has led us to develop a protocol for a combinatorial search for this "holy grail" of materials. More importantly, we have developed low cost research equipment to allow many groups to join the search for active metal oxide semiconductors.

The equipment used for the project is includes an Epson photo-quality inkjet printer and a data acquisition system built from a LEGO Mindstorms NXT robotics kit. The printer is used to print solutions of metal nitrates in a well-defined pattern on a conductive glass substrate for subsequent pyrolysis into corresponding oxides. Photoresponse characterization is performed on a laser scanning station that was built from commonly-found LEGO parts and an in-house developed electronics device centered around an inexpensive USB data acquisition card. The total cost of the equipment is ≈ $1000, allowing research groups across the country to get involved. We believe that this distributed approach will significantly speed the search for useful materials.