UNIQUE ELECTROCHEMICAL CELLS FOR THE ANALYSIS OF HYDROTHERMAL VENT PREBIOTIC CHEMISTRY EXPERIMENTS. H. D. Whitehead,[1] G. LeBlanc[1], D. M. Wirth,[1] J. Yungbluth,[1] G. Ludewick,[1] L. M. Barge[2,3] and R. D. Cameron[2,3], [1]The University of Tulsa (800 S Tucker Drive, Tulsa, OK, gabriel-leblanc@utulsa.edu), [2]NASA Jet Propulsion Laboratory, California Institute of Technology (4800 Oak Grove Drive, Pasadena, CA). [3]NASA Astrobiology Institute Icy Worlds team.

Introduction: Alkaline hydrothermal chimneys on the early Earth would have been a product of the interaction between the acidic, anoxic, iron-rich early oceans and an alkaline hydrothermal fluid resulting in the precipitation of an inorganic membrane [1-2]. Electrochemical and proton gradients produced across these membranes in some ways resemble those in cells which are used to drive metabolism, and it has been proposed that some of the first redox-driven metabolic reactions could have emerged in hydrothermal chimney systems [1,3]. For these ideas to be tested, electrochemical methods are being utilized to determine the membrane potentials and current produced both in natural systems and in laboratory mimics [2]. The study of these electrochemical properties has proved difficult due to the random nature of chimney formation and mineral deposition. Previous work has utilized a modified fuel cell approach to more systematically study these systems. [2,4]. Here we introduce the use of rapid prototyping to design electrochemical cells and components that can potentially standardize formation and characterization of these simulated chimney systems.

The field of rapid prototyping and computer assisted designed (CAD) has grown exponentially in recent years and has forever changed the way research can be conducted. Investigative research often requires modified apparatuses that are hard to reproduce and this can lead to errors in replicated studies. CAD files, however, which contain all parameters necessary to reproduce a design, can be digitally shared upon publication or through open source websites for others to simply download and replicate [5].

A contributing factor to the challenge of studing hydrothermal systems with electrochemical techniques is the requirement for electrodes to be in direct contact with the delicate chimney structure or have a carbon cloth at their interface [4]. Consequently, these measurements are often difficult to obtain and repeat. To limit this interfacial region, specialized electrochemical cells can be designed using CAD. Previous work in building specialized electrochemical cells for UV-Vis analysis has proved successful and allowed for *in situ* spectroelectrochemical experiments to be conducted (**Figure 1)**. Specialized electrochemical cells will have the ability to limit the acid-base interface and potentially create a more characteristic growth pattern.

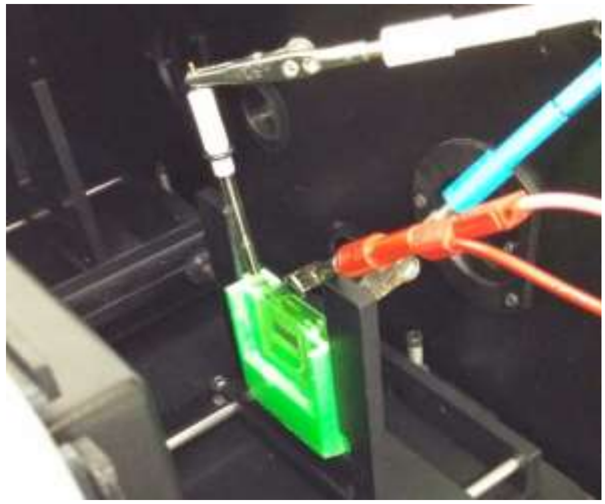

Figure 1. 3D printed flat electrochemical electrode used for *in* situ UV-Vis analysis.

Beyond the design aspect, the list of materials that can be used with 3D printers is continuously growing and enabling additional capabilities for specialization. Inexpensive, common materials such as polylactic acid (PLA) and acrylonitrile butadiene styrene (ABS) are useful for many design applications though prove incompatible with certain solvents or designs. Specialized materials such as conductive or dissolvable materials therefore represent useful alternatives in designing electrochemical cells, electrodes, and other components that would promote more structured chimney growth and analysis. If characteristic growth patterns could be simulated, then their electrochemical properties could be described more precisely, and further explain the relationship between "far-from-equilibrium" natural systems, prebiotic chemistry, and life's origins.

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