

Co-Captains: Martin Siron, Madhav Gupta Members at Conference: Ana Peccin, AnnaLaura Arredondo, Ayman Siraj, Lihao Dai, Prin Harinsuta, Hannah Adams, Kimberly Hui, Rob Young, Muhammad Sher, Malcom Gotama Members not at conference: Christian Hermanas, Miriam Bedrin, Hefzi-ba Camillo, Josh Rubnitz, Ayush Garg, Dmitry Veremeenko

## **Fuel:** Aluminum Air Battery



Reactions:

Anode:  $Al + 3OH^- \rightarrow Al(OH)_3 + 3e^- - 2.31 V$ Cathode:  $O_2 + 2H_2O + 4e^- \rightarrow 4OH^- + 0.40 V$ Overall:  $4Al + 3O_2 + 6H_2O \rightarrow 4Al(OH)_3 + 2.71 V$ 

In our design, we have used aluminum foil as the anode, oxygen from air adsorbed on activated carbon surface as the cathode and a saturated solution of sodium chloride in acetic acid as the electrolyte. Layers of foil, wetted paper towels, activated carbon and copper mesh were placed inside CD cases in order to prepare the required batteries. The electrolytic solution provides a path for the electrons to flow and current to pass between the electrodes. Over time the hydroxide ions slowly consumes the aluminum and converts it to aluminum hydroxide.

#### **Stopping Mechanism: Vitamin C Clock**



For our stopping mechanism, we are utilizing a well documented Iodine clock reaction using over the counter chemicals: Vitamin C tablets, antiseptic solution (our source of iodine), liquid starch solution, and 3% hydrogen peroxide. By controling the amount of hydrogen peroxide we put in the solution we can change how long the reaction switches from being a clear solution to being an opaque purple solution. The propogation of color only takes a few seconds to go throughout the reaction vial. At first, our clear solution is produced through the following reaction:  $I_2 + C_6 H_8 O_6 \rightarrow 2H^+ + 2I^- + C_6 H_6 O_6$ 

The hydrogen peroxide then reacts in the solution to produce the following reaction:  $2H^+ + 2I^- + H_2O_2 \rightarrow I_2 + 2H_2O_2$ 

# Traveler

## **Traveler's Beauty**



## **Testing Procedure**

Because every time we create a battery we get a different initial voltage and current, we decided to plot our theoretical velocity, that is the initial power of the car (IV) divided by the force it carries (normal force) against the average velocity the car performed over the maximum time allowed for the competition. We then correlated this performance to a linear fit. Now when we create a



battery, we can correlate its initial power to the average speed of the car and use that to coordinate the concentration of the stopping mechanism.

## **Safety Information**

All proper PPE was worn during experiments. SOPs were developed prior to experiment and each team member had to review MSDS and chemical information prior. Fume hood was used for volatile chemicals. All members had to go through a lab safety course and a TA was present and active at all labs.



First and foremost we would like to thank our advisor Dr. Richard Roberts for providing us with the support to start our team and compete at the AIChE Regionals. We would also like to thank our TA, Aaron Nichols, who helped us in lab and provided his experience at every step. We would also like to thank the USC Fabrication Lab for allowing us to use their equipment in order to design our car. We also want to thank Tina Silva, our lab manager, for allowing us to use the lab space and informing us about safety. Lastly, we would like to thank the Mork Department of Chemical Engineering and Materials Science at USC for their support and guidance in our endeavor towards participating at the Chem-E Car Competition.

April 15, 2016. AIChE Regionals, Western

### Budget

tems	Price
uel	
CD Cases, Aluminum Foil, Paper Towels,	
ctivated Carbon, Copper Mesh, Acetic	\$118.04
Acid, Salt)	
topping Mechanism	
topping Mechanism (3% H2O2, Liquid	\$55.18
tarch, Antiseptic, Vitamin C)	
Iechanical	
Wood Panels, Foam Board, Axles, Motor, Juminum Encasing, Wheels)	\$42.91
lectrical	
Copper Wires, Wire Nuts)	\$70.73
Tota	1: \$286.86

## Acknowledgements

#### References

1. Yirka, Bob. "Phinergy Demonstrates Aluminum-air Battery Capable of Fueling an Electric Vehicle for 1000 Miles." Phinergy Demonstrates Aluminum-air Battery Capable of Fueling an Electric Vehicle for 1000 Miles. Phys.org, 27 Mar. 2013. Web. 13 Apr. 2016.

2. Taylor, Gabrielle. "Classic Chemistry: Colorize Colorless Liquids with "Black" Magic, AKA the Iodine Clock Reaction." Science Experiments RSS. WonderHowTo, n.d. Web. 13 Apr. 2016.