



## Colorado Science and Engineering Fair

2024  
Team Project  
Abstract Form

Please print 2 copies of the completed form. Sign both copies, keep 1 for your notebook and submit 1 copy to your Regional Fair Director with your other paperwork.

Title of Project: Tuning the Concentration of Active Sites on the Surface of Heterogeneous Catalysts Using Self-Assembled Monolayers

Team Leader's Name: Helena Borsholm

Team Member 1: Charlotte Harrington

Team Member 2:

School and City: Monarch High School, Louisville

Sponsor's Name: Katharine Ellis

Category: Chemistry (CHEM)

Division: Senior (9th - 12th grades)

Abstract (250 words or less):

Finding catalysts that will direct reaction pathways towards desirable products, especially in the recycling of plastics, remains an issue. We can direct this reaction pathway by blocking active sites, which can be done using self-assembled monolayers (SAMs). SAM tail structure, the part of the molecule that sticks up away from the catalysts, can easily be tuned to promote specific reactions. We are looking at how different tail shapes affect the number of active sites available. We used alumina as a catalyst and phosphonic acids with varying tails to understand the relationship between tail length or width and the number of active sites still available on the catalyst. We used three different carbon chain tail lengths as seen in methyl, decyl, and octadecyl phosphonic acid as well as benzyl phosphonic to explore a wider benzyl group. Diffuse reflectance infrared Fourier transform spectroscopy allowed us to verify that the SAM was successfully deposited on the catalyst and revealed that tails of longer length form a more ordered monolayer. We then used temperature-programmed desorption to quantify the number of active sites the reactants can bind to. We found that longer tails resulted in more available active sites. The wider tail we used resulted in the least number of accessible active sites. This can be applied to using an appropriate SAM in a reaction in order to orient the reactant correctly, directing the reaction pathway, and increasing the yield of desired products. This will reduce waste produced from industrial processes.

*We hereby certify that the above statements are correct and the information provided in the Abstract is the result of one year's research. We also attest that the above properly reflects our own work.*

Team Leader's Signature: Helena Borsholm

Date: 2/29/24

Team Member 1's Signature: Charlotte Harrington

Date: 2/29/24

Team Member 2's Signature: \_\_\_\_\_

Date: \_\_\_\_\_

In addition, all students must complete the ISEF Student Checklist (1A), Research Plan, Approval Form (1B), and Checklist for Adult Sponsor (1), and any other ISEF forms required for this type of project. See the International Rules and Guidelines for form requirements. Return COPIES of all of these forms to your Regional Fair Director with your Finalist Verification/Permission Form. A signed copy of this form must be included in your notebook.