Functionalizing Glass-Based Substrates with Silanes

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Our goal is to optimize conditions to deposit a uniform coverage of silane on glass-based substrates. Silanes bond to surfaces to change their surface chemistry. This is called functionalization. In one study, we immersed glass in chlorotrimethylsilane (CTMS) in toluene for 20 min and measured the contact angle of a water drop on the surface. We obtained the plot shown above. Contact angle is related to surface coverage. Clearly, surface coverage increases with solution concentration as we expected. Different solvents or different glasses may have different reactions. We have explored this using acetonitrile and ethyl acetate, so-called bio-compatible and green solvents. With some chemical reactions, longer times can give even higher yields. Reaction rates also increase with temperature. I invite you to help address the other issues in further studies. A summary of the project status is posted on ResearchGate.

Duties, Contributions, and Outcomes

This RCEU project is designed for students who want to learn how to perform robust hands-on chemistry-type experiments, how to use a contact angle goniometer, and how to analyze contact angle data.

The first objective in the first two to three weeks is to generate a written plan of attack. Your duties are to review relevant literature and to repeat previous base-line experiments in our group. Your final duty is to write a proposed plan that outlines such factors as the number of measurements you plan to make and the experimental protocols for each type of system (solutions and films). You have an opportunity in this research project to make substantial contributions to define the research direction of the project immediately at the outset. Aspects such as the type of substrate and the solution conditions are open
to consider. The second objective over approximately the next six to seven weeks is to perform, document, and report on measurements that you make. Your primary duties are to prepare solutions, functionalize substrates, characterize them with contact angle goniometry, and analyze the results for quantitative information. The final objectives are to prepare a written report of your results and to complete the RCEU Poster.

The primary contribution of your work is that you will expand our ongoing analysis of functionalized surfaces. You will be encouraged to write your results as a publication for Perpetua. With a sufficient collection of substantive results, we plan to publish the work in a peer-reviewed journal.

You will learn how to prepare silane solutions and to functionalize surfaces. You will learn how to measure contact angles and analyze them. You will learn how to prepare publication-ready reports.

**Requirements and Mentorship**

**Requirements:** You must have successfully completed CH 121 and CH 123 with the labs.

**Preferences:** Preference will be given to students who have also taken CH 224 or CHE 295. Preference will also be given to students who are willing to take a one-credit independent research course in Spring 2019 to establish the groundwork for the first objective. Taking this step will give a greater chance that your results are substantial enough to publish in an external peer-reviewed journal.

You will be supervised by me (Dr. J. J. Weimer). In the first two weeks, you will schedule time with me to collect literature and prepare protocols to share documents. You will also schedule time to learn how to prepare the solutions and functionalize surfaces. In the third week, you will schedule time with me to learn how to use the contact angle system. The hands-on efforts should involve about half of your time, with the other half for literature review and writing a project plan. Once you start your experiments, we will meet on a weekly basis on a fixed schedule (e.g. every Friday morning). You will present an oral report that outlines your progress, presents any issues, and proposes your plan of attack for the coming week.

I will be openly available at all times during the project to address questions. We will correspond directly, via email, and using Skype or Zoom.