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Functionalized Glass-Based Substrate with Silanes

Jeffrey J. Weimer
University of Alabama in Huntsville

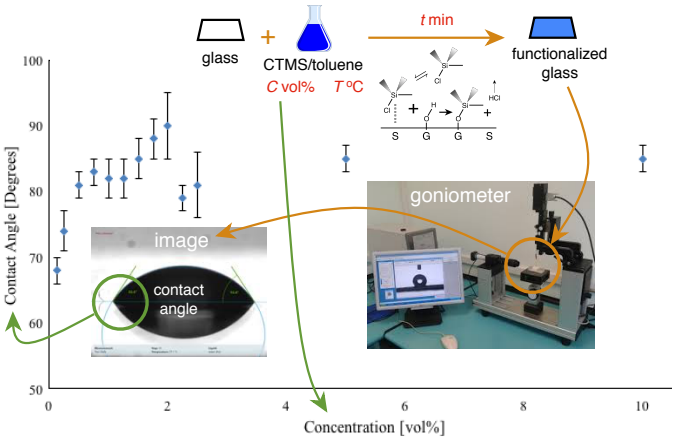
Functionalizing Glass-Based Substrates with Silanes

UAH RCEU 2018 Proposal

Dr. Jeffrey J Weimer, Jeffrey.Weimer@uah.edu, 256-824-6954

Associate Professor, Chemistry / Chemical & Materials Engineering, MSB 125

Background and Motivation



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. We invite you to help us address these other issues in further studies. A summary of the project status is posted on ResearchGate.

Prerequisites

This RCEU program is designed for students who want to expand their skills to do effective wet-chemistry experiments, to learn how to measure contact angles, and to perform robust data analysis. You must have successfully completed two course in General Chemistry (CH 121 and CH 123) with the labs. Students who have had a lab in quantitative chemistry (CH 224), the first section of physical chemistry (CH 345), and/or in materials (CHE 295) are preferred. In the case of multiple requests, students who demonstrate the best experience for, clearest interest in, and greatest appreciation of the basic research work will be given preference.

Duties

Your first objective is to define your research in context of what we have done already. You will generate a project proposal. You will repeat the measurements needed to obtain the data that are

shown in the background figure. In parallel, you will define protocols for your experiments. How will you work effectively to cover the variables (glass substrate chemistry, solvent, solution concentration, time, and temperature) in time to end the RCEU program successfully? How many samples will you measure to obtain statistically representative results? The challenges are to repeat existing experiments reliably and to define how to apply the existing methods to obtain the best results. Your outcomes are better skills to do wet-chemistry experiments and contact angle measurements as well as improved confidence to design protocols for an experiment.

Your second objective is to perform, document, and report on the measurements that you make. You will have nearly until the end of the program to complete this according to your timeline. You will prepare samples and characterize them. Each week, you will present brief written and oral reports on your progress. The challenges in this project are to stay on-task in respect to your proposed time-line while dealing with mistakes, misfortunes, or mis-adventures and to report what you have achieved in a concise, informative, and well-structured manner. Your outcome is improved skills in wet-chemistry labs, a deeper understanding of contact angle as a measurement tool for surface chemistry, and better report-writing abilities.

The final objective is to prepare a final report. You will analyze contact angles to obtain averages and uncertainties. You will report your data as a function of the parameters you choose to vary in publication-ready graphs, and you will present them in the RCEU poster session. Your outcome is a public presentation that you can document on your résumé as a primary author. Your contributions will also be fully acknowledged in any other publications that use what you have generated.

An advanced level of effort is also open. You should have a background in statistical data analysis and regression curve fitting. You should demonstrate knowledge of kinetic rate laws and thermodynamic equilibrium expressions. The extra effort will take the project beyond just preparing samples, characterizing them, and plotting the resultant data. You are encouraged to set this path on your own. The target outcome is the potential for co-authorship on a journal publication.

Mentor Supervision and Interaction

You will be supervised by me (Dr. J. J. Weimer) and a graduate student. We will train you how to clean and functionalize the samples and how to measure contact angles (Objective 1). We will demonstrate how to analyze the data in a spreadsheet and how to generate publication-ready reports and posters (Objectives 2 and 3). When you are prepared for the advanced effort, I will provide equations to translate contact angles to coverage and tools to do non-linear regression analysis.

We will meet routinely (on a weekly basis). The graduate student and I will be openly available to address questions. We will correspond directly and via email, Skype, Canvas, and Google Drive.