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Spectroscopic Determination of the Binding Constant and Thermodynamic Values of a Host-Guest System

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A host-guest system occurs when a guest molecule, in this case Brooker's merocyanine (BM), enters the host molecule, beta-cyclodextrin (β-CD), to form a complex. The equilibrium of a host-guest system becomes established through weak intermolecular interactions when the guest molecule binds to the host. The strength of the interactions can be studied using the equilibrium binding constant. By altering the structure of the β-CD through modifications of the chemical substituents along the outer rims of the β-CD cavity, we can better understand the different types of interactions between host and guest, such as hydrogen bonding and van der Waals forces. The determination of the binding constant at different temperatures allows for further understanding of these complexes. To determine the binding constant, the Benesi-Hildebrand equation can be used to analyze data collected using fluorescence spectroscopy. The binding constant of β-CD complex does appear to be temperature dependent, so the thermodynamic values of ΔG, ΔH, and ΔS were calculated. However, the binding constants for some of the modified β-CD complexes do not appear to exhibit a strong temperature dependence, so these thermodynamic values were not determined. Determining the temperature dependence of these complexes allows better insight into how strong the modified β-CDs will bind to a guest molecule, which allows for better predictions of their behaviors under different conditions.

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Electrodeposition and Dealloying of Nickel-Cobalt and Nickel-Cobalt-Copper Thin Films

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This project focuses on characterizing nickel-cobalt and nickel-cobalt-copper electrodeposited thin films. These films can be engineered to have high surface areas, giving them fuel cell and capacitance-related applications. Using a three-electrode electrochemical cell, metal alloys are deposited from solution onto a gold substrate. These films are then studied in a scanning electron microscope (SEM) with an energy dispersive x-ray spectroscopy (EDS) attachment to determine their structures and compositions. It was found that when nickel and cobalt are deposited together, there is consistently a higher ratio of cobalt in the film than in the solution. When nickel, cobalt, and copper are deposited together, the ratios in the film are generally closer to those in the solution, but there is more nickel in the film than in the solution. The nickel-cobalt and nickel-cobalt-copper films are then electrochemically dealloyed. To dealloy the films, a steadily increasing potential is placed between the working and counter electrodes, re-oxidizing the metals and pulling them off of the substrate. Different metals re-oxidize at different potentials, so depending on when one stops the potential, it is possible to pull out certain metals, leaving others behind. When dealloying the nickel-cobalt films, nickel and cobalt strip out of the film in nearly equal amounts, despite cobalt reacting at a lower potential. When dealloying nickel-cobalt-copper, nickel and cobalt are kinetically stabilized, and the copper pulls out, leaving a porous nickel-cobalt film behind. Preliminary results also suggest that dealloying the nickel-cobalt-copper films increases their capacitances.