UNIT TWO: INTRODUCTION TO ELECTROSTATIC SELF-ASSEMBLY

Group Members: ______________________________

Class: ______________________________

Period: ______________________________

Date: ______________________________

Purpose : This series of exercises will allow you to investigate ESA components, ESA procedures, ESA film structures

Materials: 1 tongue depressor with Velcro strip
8 white Velcro buttons
8 black Velcro buttons
1 'smudge' strip

EXERCISE 2.1: Preparing 'Solutions'

1 - Separate the pieces into three separate piles.
- The Anions are the white Velcro loop buttons.
- The Cations are the black Velcro hook buttons.
- The Substrate with a negatively charged (anionic) surface is the tongue depressor with the white Velcro strip.

Is the Cation positively or negatively charged???

Is the Anion positively or negatively charged???

CONTROL EXPERIMENT
EXERCISE 2.2: Formation of a simple ESA film

Identify at least 5 constants in this experiment:

1 - Place the substrate with the Velcro strip facing up.

The Velcro strip simulates negative charges. Most substrates we use do not have a negative charge in their normal state. We create these charged surfaces chemically. This is normally accomplished by either chemically bonding a molecule with a negative charge or by immersion in an acid to break a bond on the surface thus leaving behind negatively charged sites.

2 - Build a Cationic monolayer. Try to place all the Cation buttons on the substrate.

This simulates immersion of the substrate in a Cationic solution. In solution the opposite charges will attract each other and the cations will migrate through solution to the surface. Once near the surface the positive charges (cations) will form an ionic bond with the negative charges on the surface.

3 - Rinse the monolayer. Remove all Cation buttons that are not completely adhered to the substrate. Place these ions back in the Cation pile.

This simulates a rinse step. In the rinse step all ions that are not ionically bonded to the surface are removed. By using a pure water rinse any ions not firmly bonded to the surface will migrate by diffusion away from the surface and will be removed by the rinse.

4 - Build and Rinse an Anionic Monolayer. Repeat steps 2 and 3 for using Anions instead of Cations. You now have one bilayer.

5 - Build and Rinse a second bilayer by repeating steps 2-4

6 - Inspect the film; it should be 4 layers of alternating colors

EXERCISE 2.3: Using only anion molecules

What is the Independent Variable?

What is the Dependent Variable?

What is your hypothesis—what do you think will happen in this exercise?

1 - Separate the last film into the 3 separate piles.
    - The Anions will be the white Velcro buttons.
    - The Cations will be the black Velcro buttons.
    - The Substrate with a negative charged (anionic) surface will be the tongue depressor with the white Velcro strip.

2 - Place the substrate with the Velcro strip facing up.

3 - Build an Anionic monolayer. Try to place all the Anion buttons on the substrate.

4 - Rinse the monolayer. Remove all Anion buttons that are not completely adhered to the substrate. Place these ions back in the Anion pile.

5 - Repeat steps 3 and 4 two more times.

6 - Inspect the film; how many layers are built up?

7 - Write down any observations

EXERCISE 2.4: Substrate contamination

What is the Independent Variable?

What is the Dependent Variable?

What is your hypothesis—what do you think will happen in this exercise?

1 - Separate the last film into the 3 separate piles.
   - The Anions will be the white Velcro buttons.
   - The Cations will be the black Velcro buttons.
   - The Substrate with a negatively charged (anionic) surface will be the tongue depressor with the white Velcro strip.

2 - Place the substrate with the Velcro strip facing up.

3 - Place the fingerprint smudge Velcro Hook strip in the middle of the substrate.

   This simulates an oil smudge or fingerprint. This is one of the most common causes of poor films. The smudge is an uncharged high surface tension surface. The high surface tension prevents the water-based solutions from properly interacting with the surface and the lack of charge prevents bonding if there was adequate interaction.

4 - Build a Cationic monolayer. Try to place all the Cation buttons on the substrate.

   This simulates immersion of the substrate in a Cationic solution. In solution the opposite charges will attract each other and the cations will migrate through solution to the surface. Once near the surface the positive charges (cations) will form an ionic bond with the negative charges on the surface.

5 - Rinse the monolayer. Remove all Cation buttons that are not completely adhered to the substrate. Place these ions back in the Cation pile.

This simulates a rinse step. In the rinse step all ions that are not ionically bonded to the surface are removed. By using a pure water rinse any ions not firmly bonded to the surface will migrate by diffusion away from the surface and will be removed by the rinse.

6 - Build and Rinse an Anionic Monolayer. Repeat steps 4 and 5 for using Anions instead of Cations. You now have one bilayer.

7 - Build and Rinse a second bilayer by repeating steps 4-6

8 - Inspect the film; it should be 4 layers of alternating colors.

9 - Write down any observations

EXERCISE 2.5: Mixing the anion and cation solutions together

What is the Independent Variable?

What is the Dependent Variable?

What is your hypothesis—what do you think will happen in this exercise?

1 - Separate the last film into the 3 separate piles.
    - The Anions will be the white Velcro buttons.
    - The Cations will be black Velcro buttons.
    - The Substrate with a negative charged (anionic) surface will be the tongue depressor with the white Velcro strip.

2 - Place the substrate with the Velcro strip facing up.

3 - Combine the Anion and Cation solutions.

4 - Have one group member knead the two piles of buttons together.

5 - Build and Rinse a monolayer. Use same procedure as steps 2 and 3 from first exercise.

6 - Inspect the film; what happened to the Velcro buttons?