Investigation of Ag and Au Nanoparticles Assembly Using Dopamine Adhesive Layers in Solar Cells

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Outline

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Introduction

Nanotechnology

Test conductivity in solar cells

Implementation of the Dip-Coating Method

Adhesive Properties of Dopamine for the

Gold and Silver nanoparticles.
A solar cell is a photovoltaic cell.

It is generated by the excitation of photons.

In this experiment TiO$_2$ will be used as an electrochemical sensor.

Dopamine and a mixture of Au and Ag nanoparticles will be used to test in order to see if the solar cell will be more efficient.
Background Information

Dopamine

Dopamine is a neurotransmitter present in the body that can act as an adhesive. Known to coat plastics or glasses, along with joining two substrates. Able to absorb onto all surfaces and self-polymerize into thin hydrophilic films.

Nanoparticles

Ability to absorb a wide range of spectrum light waves. At a specific wavelength (frequency) of light, collective oscillation of electrons on the gold and silver nanoparticle surface cause a phenomenon called surface plasmon resonance resulting in strong extinction of light. Frequency of light where this occurs is strongly dependant on the nanoparticles size, shape, surface.
Hypothesis

If a mixture of silver and gold nanoparticles are coated with dopamine and incorporated in the solar cell after the dye layer, then the solar cell will be more efficient at absorbing more light, thus, producing more voltage.
Specific Objectives 1

Coat the silver and gold nanoparticles with the Dopamine and apply it to the solar cell
Specific Objectives 2

- Mixture of gold and silver with Dopamine
  - Dip-coat two glass slides with dopamine for 24 hours.
  - Dip-coat one of the slides with the mixture of Au and Ag nanoparticles.
  - Dip-coat the second glass slide with Au only.
Specific Objectives 3

Layering order to achieve conductivity of solar cell

Test twice: One adding the Dopamine before the dye and the other adding the Dopamine after the dye.
Conceptual Approach

Layering is used to coat other substances.

Achieved by dip-coating slides onto substrates

An approach to incorporate nanoparticles in the solar cell

Layering was first used to coat the TiO$_2$ with dopamine.

The dopamine was then coated with the dye.

The dye was finally coated with the mixture of Au and Ag nanoparticles.
Experimental Procedure

Tape two conductive slides and create titanium dioxide powder

3 mL of 1M acetic acid with 20 mL of DI water, mix until paste-like

Create dye by smashing blackberries until liquid solution. Mix 5mL of DI water with liquid

Spread titanium dioxide paste on glass slides, thin layer with spatula

Heat slides to 450° Celsius for 30 minutes

Cool for 10 mins
Experimental Procedure

Create Dopamine solution

2mg of Dopamine per 1 mL of 10 mM and mix to dissolve

Dip-coat one slide into the blackberry solution for 10 minutes then rinse

Dip-coat the second slide with titanium dioxide in dopamine for 1 hour

The slide with the dye, once rinsed, dip coat in dopamine for 1 hour

After dip coating
Experimental Procedure

Take two other slides, tape and cover it with graphite using a graphite pencil.

Place graphite slide and titanium dioxide together, leaving \(\frac{1}{8}\) of an inch out at both ends.

With two clips, clamp each side, keeping the slides together and leaving the center open.

Take 4 drops of potassium iodide and place in-between slides.

Test voltage using multimeter with different light sources (ex. Room light, sunlight, iPhone flashlight).
Results and Discussion

In the first image, the solar cell that was tested was the one that consisted of the addition of the dye first, then dopamine. It reached up to 380 millivolts when tested outside and 164 millivolts inside.

In the second image, demonstrates the solar cell that had the dopamine applied first, then the dye. For this solar cell, it reached up to 314 millivolts and 143 millivolts.

The results showed that the solar cell that had the dye added first, followed by the dopamine, was more effective.
Conclusion

In experiment 1, the nanoparticles were mixed with dopamine, in a vial. It was concluded that experiment one did not work due to the increase of size of the nanoparticles.
Conclusion

Experiment 2, consisted of dip-coating the dopamine and the mixture of Ag and Au nanoparticles, allowing them to sit for nearly 24hrs, expecting both, dopamine and mixture to form a thin layer on the glass slide. This experiment allowed us to determine that the mixture of gold and silver were better than gold nanoparticles alone.
Conclusion: Experiment 2 Continued
Conclusion

Experiment 3, the layering order was analyzed by controlling the time, when the dye would be incorporated, either before or after the dopamine. After testing both solar cells, the solar cell with the dye incorporated before the dopamine, had the highest voltage.
Conclusions

Experience through proper research techniques

Knowledge on solar cell techniques

How to conduct a research proposal

Team work

Nanotechnology as a whole
Future Work

Test silver nanoparticles for experiment 2

Use the proper conductivity glass slides
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References


Questions??