Solid State Device from Plant Extracts

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Abstract. The infusion of green solution into solid-state technology is timely at a time where land, air, and water pollution (from electronic waste) is high in most parts of the globe. At the moment, several research works have proven that plant extract doped with metallic compound exhibits high electrical, optical and chemical properties. In this research we examine two different plant extracts with different dopant. The special opto-transport property of the synthesized compounds was examined using an unconventional characterization technique. It was observed that both compounds can be identified as solid-state device with remarkable optical properties.

1. Introduction
Solid-state devices are systems or electronic components solely dependent on a semiconductor. They allow electricity to flow through a solid semiconductor crystal like silicon, germanium, and gallium arsenide. In recent times, the definition of solid-state becomes more interesting with the emergence of different material in solid and liquid state. Other than the normal explanations given for solid-state devices, it is also often described as semiconductor electronics or electronic equipment that uses devices like transistor, integrated circuits and others. Other example of solid-state device includes LED lamps, solar cells, CCD image sensor that many people use in cameras and semiconductor laser [1-3]. Another application of solid-state devices is in computers i.e., in form of component or storage device. Semiconductors are known to have electrical conductivity between that of an insulator and that of most metals, either due to the addition of an impurity or because of temperature effects. Examples of the most famous semiconductors used nowadays are the Transistor and the Junction diode [4-5]. They are electronic device that works due to the movement of electrons in a solid piece of semiconductor material. The emergence of liquid semiconductors has proven that the physics in solids can be replicated in liquids. Liquid solid-state device includes hydrogenated amorphous silicon and mixtures of arsenic, selenium and tellurium in a variety of proportions. They are generally used in thin film structures, which do not require material of higher electronic quality. Since the creation of the transistor, solid-state devices have developed at a wonderful rate [6]. Maximum efforts have been put towards the methods they are made and there is no limit to the devices in future.

The idea of green solution into electronics was borne via the massive pollution from electronic wastes. Several deaths and diseases are reported all over the globe from electronic waste [7]. The rate of death is higher in developing countries where there are no regulation guiding waste disposals. Despite there are laws to guide the production of solid-states device or electronics gadgets, the long term danger of
controlling its waste still subsists. The idea of using plant extracts became prominent because it believed that the plant wastes are mostly biodegradable. Also, some plants contain vital chemical components that make it a good candidate as semiconductor. For example, garlic is known for being rich in both germanium and selenium. Now the content of selenium alone is very dependent on its availability in the soil and this is based solely on the location. The presence of these two elements is very high in garlic compared to some fruit and vegetable like potato, carrot, apple etc. According to research conducted by notable scientists and researchers worldwide, it has been found that both of them possess contents of about 2.78 and 0.276 µg g\(^{-1}\) respectively in garlic [8]. Some of these plants are mined to get certain chemical elements or compounds. During plant mining, some chemicals are used for the extraction process for different concentration and quantity of the desired elements [9-11]. The final product certainly would not be regarded as biodegradable.

The use of unprocessed plant extract in itself is frustrating because plant contains hydrogen and carbon in disturbing quantities that makes it an insulating liquid. The idea of doping the extract with certain quantities of impurities or metallic compounds is to allow for the chemical engagements of some of the redundant chemicals in plants [7]. The bonding or antibonding is more prominent and can be varied based on the concentration of the dopants. However, the quantity of the dopant is very important, as the basic aim of this experiment is to avoid long-term electronic wastes. In this study, the two different plants extract with different dopants were analyzed determine its opto-lectrical properties [12-13].

2. Methodology
Ixora plants are small shrubs that grow in subtropical regions. These plants feature large clusters of red, yellow, white, or orange flowers that emerge like puffballs from the evergreen leaves. The phytochemical screening of ixora plant reveals the following compounds: phenols, alkaloids, flavonoids, terpenoids, coumarins, tannin, saponin, anthocynin, anthraquinone and amino acids [14]. Flavonoid is found to be the main chemical in the ixora plant.

The flow chart of the methodology is presented in Figure 1. The flower was rinsed in water and placed in a filter to drip its water over night. The flower was grinded using methanol alone. The filtrate was filtered to obtain a red extract. The extract was doped with 0.01M of copper nitrates compound and thoroughly mixed. The doped plant extract was allowed to react under room temperature and pressure for a day.

The second method is to characterize the liquid semiconductor using unconventional characterization technique to test the opto-transport properties of the doped plant extract (Figure 2). The doped plant extract was sprayed on a photovoltaic (PV) to monitor its opto-transport.

![Flowchart of methodologies](image)
Figure 2. Physics of unconventional characterization technique

A clean photovoltaic panel that is placed at the same time with the sprayed PV to remotely monitor the physics of the doped plant extract. The opto-transport is monitored by the differing voltage output of the both PV panels. The solid-state film (doped plant extract) is expected to react first before the solar irradiance passes to the PV panel. The opto-transport of the solid state film can be determined by the equations below.

\[ A = -\log \frac{I}{I_0} = -\log \left( \frac{V_{\text{sample}} - V_{\text{zero}}}{V_{\text{solvent}} - V_{\text{zero}}} \right) \]  

(1)

Where A is the absorption, \( V_{\text{sample}} \) is the voltage on the clean PV module; \( V_{\text{solvent}} \) is the voltage of the sprayed PV module. \( V_{\text{zero}} \) is the differential voltages between the sprayed and unsprayed PV module.

3. Results and Discussion

Ixora coccinea flower is of ursolic acid chemotype [15]. The formulor of the ursolic acid is \( \text{C}_{30}\text{H}_{48}\text{O}_{3} \). After the compound was doped, the chemical reaction is

\[ 33\ H_2O + 64\ CuNO_3 + 7\ \text{C}_{30}\text{H}_{48}\text{O}_{3} = 64\ CuNC_3H_6O_3 + 18\ HCO_3. \]

The XRD was examined at wavelength 1.54056 nm. The XRD results show that the compound is polycrystalline with copper. The copper atom is the highest peak with plane and d-spacing as (002) and 8.493Å. The nitrogen element is on plane (012) and d-spacing of 7.17Å; carbon element is on planes (100), (022), (110) and with d-spacing of 5.41 Å, 5.26 Å, 5.02 Å respectively. The hydrogen element is on planes (10-2), (11-2), (121) and with d-spacing of 4.65 Å, 4.40 Å, 4.06 Å respectively. The remaining peaks are the oxides and the unidentified peaks. The second type of characterization is the unconventional techniques presented in Figure 4.
Figure 3. XRD of doped plant extract
Figure 4. Unconventional characterization technique of the doped plant extract

The red lines in Figures 4a, c, e & g represents the voltage from unsprayed PV module while green lines are in Figures 4b, d, f and h represents the voltage from the sprayed PV module. The features of the peaks in the unsprayed PV modules are in lines and curves, while the voltages in the sprayed PV module are in peaks. This is because the doped plant extract is a liquid semiconductor that converts the original solar signals on the PV module. The different patterns shown in Figures 4a, c, e & g are dependent on solar irradiances that are incident on the surface of the PV module. The absorbance of the solid-state device shows that it reacts significantly to different signals from the solar irradiance (Figures 4b, d, f and h). When there are more curves above the ‘line of average’, it gives normal peaks in the solid-state device and the absorbance results. In other words, Figure 4 a & b is in its stable state. When there more curves below the ‘line of average’, the system is unstable and there are likely cases of anti-bonding i.e. judging by the crossed line over the peaks (green line in Figure 4c). In this case, the absorbance shows that the solid-state slightly perturbed. Figures 4e & f shows that the sectional transient states on the doped plant extract and the solar cells in the PV module. At harsh solar irradiances, the absorbance of the doped plants is tremendously controlled, i.e. making it a very good solid-state device.

4. Conclusion
In conclusion, it is wise to note that these solid-state device found in the doped plant extracts are advantageous for safety of humanity by reducing death from e-wastes pollution and for economical purposes. This invention will become a great source of value to the electronic world considering the fact that they have good opto-transport properties to act as bio-filter to shield PV modules from harsh weather. Also, the new solid-state device shows that it can be upgraded into switching device such as metal–oxide–semiconductor field-effect transistor (MOSFET). There are other verse uses of the new solid state.
The unconventional characterization technique has shown to be very effective in determining the opto-transport properties of the new solid-state device. It is recommended that the molecular dynamics of the new solid-state device be investigated to see the best way to optimize the new material.

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