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Retraction

Retracted: Analysis of Pomegranate Dye Coated Titanium Nanotubes Anode for Solar Cell Application

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This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] P. Thenmozhi, P. Sathya, S. Meyvel, and S. Thanappan, "Analysis of Pomegranate Dye Coated Titanium Nanotubes Anode for Solar Cell Application," *Advances in Materials Science and Engineering*, vol. 2022, Article ID 3278255, 7 pages, 2022.

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Research Article

Analysis of Pomegranate Dye Coated Titanium Nanotubes Anode for Solar Cell Application

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The titanium nanotube array is termed as titanium nanotubes anode (TNTA). Initially, four samples of TNTA were synthesized using electrochemical anodization method. The titanium nanotube arrays (TNAs) were fixed as anode for dye-sensitized solar cell application. The execution of dye-sensitized solar cells (DSSCs) is found on natural dyes removed out from natural materials. Then, pomegranate dye was exclusively prepared and coated on TNTA samples. These are very affordable and inexpensive and are abundantly available in India. The dye coated TNTAs were distinguished using UV-viewable spectrophotometer and SEM test for their spectral effects. The natural dye showed a wide-ranging absorption performance peak between 300 and 574 nm for the second sample and 300–572 nm for third sample. Their solar absorption property was studied.

1. Introduction

Gratzel's Dye-Sensitized Solar Cell (DSSC) emerged in 1991 [1] and came to notice because of its eco-friendly and low manufacturing cost. ADSSC consists of a nanocrystalline semiconductor permable anode soaked with dye, cathode, and an electrolytic solution of iodide and tri-iodide ions, respectively. Sensitizing dyes of DSSC absorbs light from solar energy and converts it in to electrical energy. Plenty of synthesized organic dyes and metal complexes are used as sensitizers. In spite of high relative efficiency, utilization of valuable material like ruthenium (Ru) complexes makes pitfall of DSSC. Also, its manufacturing cost is high due to the utilization of deficient noble materials. Reports prove that organic dyes are 9.85% efficient and low cost. Low yield and complicated synthesis are the major problem associated with natural dyes. However, it is easy to extract natural dyes from flowers, leaves, and fruits. Because of its low cost, nontoxic, and retro gradations nature, natural dyes have emerged a topic of interest. Till now, several natural dyes like carotene, chlorophyll and so on are used in DSSC as sensitizers.

DSSCs are based on the photo sensitization created by dyes on broad band-gap mesoporous oxide of metal semiconductors; this is because of the dye inclusion value of part of light spectrum noticed [2, 3]. The sensitized dye plays a major role in absorption of sunlight and converting the same into electrical energy. Fabricated metal complexes and various organic dyes like porphyrins [4], phthalocyanines [5, 6], platinum complexes [7], and fluorescent [8] are utilised as sensitizer.

Ru-based complexes sensitizers are extensively used in DSSC application due to their superior efficiency and long lasting nature. However, they also have several disadvantages like high cost, complex extraction methods, and ready to degrade with water [9]. The use of natural pigments as sensitizer is exciting due to its economical impact and environmental concern [10, 11]. Natural dye pigments extracted from vegetables and fruits [12–14] such as anthocyanins and chlorophyll are utilised as natural sensitizers in DSSCs.

About 0.66% transformation efficiency is obtained by utilising natural red Sicilian orange juice dye as sensitizer

[14]. Natural dye sensitizer attained maximum efficiency of 0.70% [15]. Rose Bengal dye produced a maximum efficiency of 2.09% [16]. Coumarin natural dye produced a maximum efficiency of 7.6% [17–20]. This work focuses on the accomplishment of pomegranate natural dye removed out from pomegranate fruit which has been reported as it is inexpensive and abundantly available in India [21]. The achievement of DSSC mainly depends on the dye. The dye must have the essential characteristic like powerful absorption in the visible light spectrum, bear an appropriate fitment of the chemical group, and establish electrons over the semiconductor surface [22–24].

2. Materials and Method

2.1. Electrochemical Anodization Method. In this work, the samples of vertically oriented titanium nanotubes anode (TNTA) have been synthesized by the electrochemical anodization process. In this work, all four samples of size $10 \times 10\,mm^2$ were used. Mixture of ethylene glycol is used as anodising electrolyte. DI water and NH4F salt at different proportions. Anodization was performed at different four DC voltages. The experiments were performed at slightly above the room temperature under magnetic agitation. During the characterization, surface morphology and absorbent power of the four samples were studied by HRSEM, and UV-Visible Spectroscopy.

2.2. Preparation of Natural Pomegranate Dye. The sweet pomegranate used in this study was obtained from 7-year-old sweet pomegranate tree grown in India. The samples of pomegranates were collected from a natural source at random. During the 2018 growing seasons, they were harvested. 2 kg of fresh pomegranate was used to coat the single sample, and dye solution weighing 20 g was removed out from 150 ml of DI water at 36°C. This process has taken about 20 minutes. DI water is mixed with pomegranate and introduced into an ultrasonic cleaning machine for 20 minutes at 37 Hz frequency for dye removal under Degas mode. Finally, the solvents are agitated in a centrifugal machine at 250 rpm for 30 minutes.

Solid impurities were removed to obtain a clear dye solution. Pomegranate natural dye has been applied as sensitizers for four TNTA samples. Pomegranate natural dye had been removed out using DI water from the pomegranate fruit. Dye had been applied for TNTA samples and tested characterization of TNTA samples. With the intention of the fine-tuning of this research work, natural dyes are suitable alternative photo sensitizers for titanium nanotubes anode. Natural dyes are an environmental friendly and low cost. Figure 1 shows the pomegranate and pomegranate dye.

All the four samples of titanium nanotubes anode were soaked in pomegranate dye for 12 hours and dried in dark place. Pomegranate dye coated all the four TNTA samples characterizations have been analyzed by using SEM test and UV-Visible Spectroscopy test.

Finally, the UV-Visible Spectroscopy test values of the pomegranate dye coated titanium nanotubes anode samples were examined. The natural dyes have enhanced the photon energy absorbing capacity of titanium nanotubes anode samples, and it was confirmed from the UV-Visible Spectroscopy results. The natural dye will enhance the solar radiation absorption capability of the titanium nanotubes anode (TNTA) samples. Also, natural dyes will increase the electron flow in the dye-sensitized solar cell. It would enhance the dye-sensitized solar cell (DSSC) execution. Hence, the second sample and the third sample are the best samples, and it would be suitable for solar cell applications.

3. Result and Discussion

3.1. HRSEM Study of TNTA Samples. The high resolution scanning electron microscopy (HRSEM) had recorded the top view images and the cross section images of the four titanium nanotubes anode samples. The HRSEM top view image confirms the formation of titanium nanotubes anode (TNTA) samples, fabricated at 60 V, 75 V, 40–20 V, and 50–25 V. Figures 2 and 3 exhibit the titanium nanotubes.

3.2. SEM Study of Pomegranate Dye Coated TNTA Samples. The scanning electron microscopy (SEM) had recorded the top view images of the pomegranate dye coated four titanium nanotubes anode samples. The SEM top view image confirms the deposition of pomegranate dye uniformly on the titanium nanotubes anode (TNTA) samples, fabricated at 60 V, 75 V, 40–20 V, and 50–25 V. Figures 4 and 5 exhibit the dye coated on the TNTA samples.

3.3. UV Measurements Study of TNTA. UV-Viewable spectrophotometer was utilised to evaluate the absorbance of removed out natural dyes and sensitized photo electrodes. Ultraviolet-visible spectrophotometer device inspected the contact of light radiation with titanium nanotubes anode (TNTA) thin foil in the ultraviolet (200–400 nm) and visible (400–800 nm) range value.

UV-Viewable spectrophotometry is the commonly employed methods in the solar cell research analysis. It includes measuring the amount of ultraviolet or viewable radiation captivated by a titanium nanotubes anode (TNTA) thin foil samples. The device which recorded the ratio of the intensity of two beams of light in the UV-Viewable region area is known as ultraviolet-visible spectrophotometer device.

The absorption spectrum value of the pomegranate dye was noted to know its light absorption performance of the titanium nanotubes anode (TNTA) samples. Figure 6 shows the UV pattern of first TNTA sample with pomegranate dye. The natural dye showed a wide-ranging absorption performance peak value between 300 and 570 nm. The maximum absorption performance value is 570 nm.

The absorption spectrum value of the pomegranate dye was noted to know its light absorption performance of the titanium nanotubes anode sample. Figure 7 shows the UV pattern of second TNTA sample with

Figure 1: Sweet pomegranate and pomegranate dye.

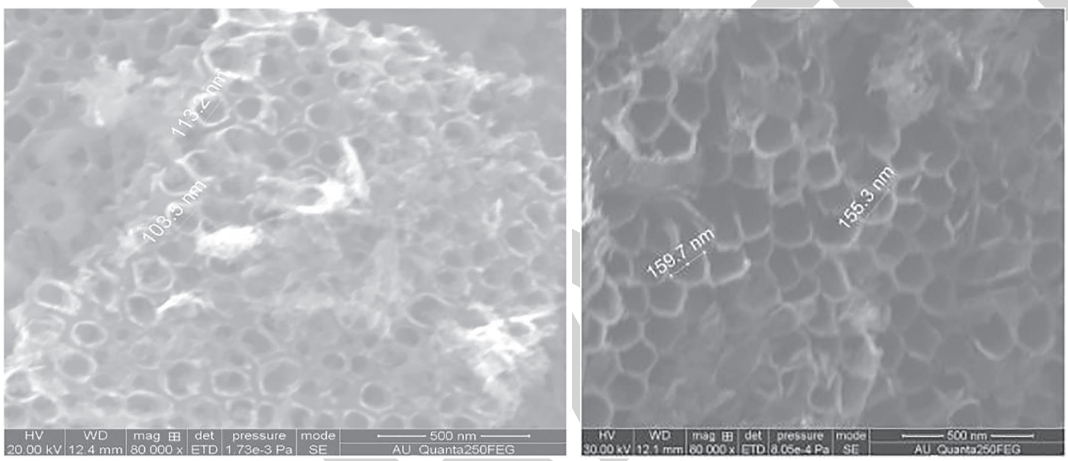

Figure 2: HRSEM top view of TNTA fabricated at 60 V and 75 V.

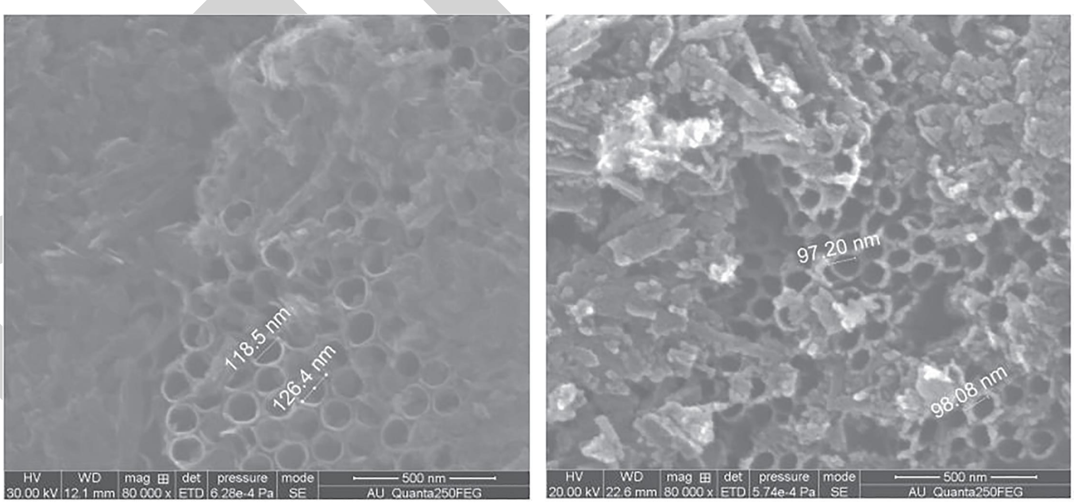

Figure 3: HRSEM top view of TNTA fabricated at 40–20 V and 50–25 V.

pomegranate dye. The natural dye showed a wide-ranging absorption performance peak value between 300 and 574 nm. The maximum absorption performance value is 574 nm.

The absorption spectrum value of the pomegranate dye was noted to know its light absorption performance of the titanium nanotubes anode sample. Figure 8 shows the UV pattern of third TNTA sample with pomegranate dye. The natural dye showed a wide-ranging absorption performance peak value between 300 and 572 nm. The maximum absorption performance value is 572 nm.

The absorption spectrum value of the pomegranate dye was noted to know its light absorption performance of the titanium nanotubes anode fourth sample. Figure 9

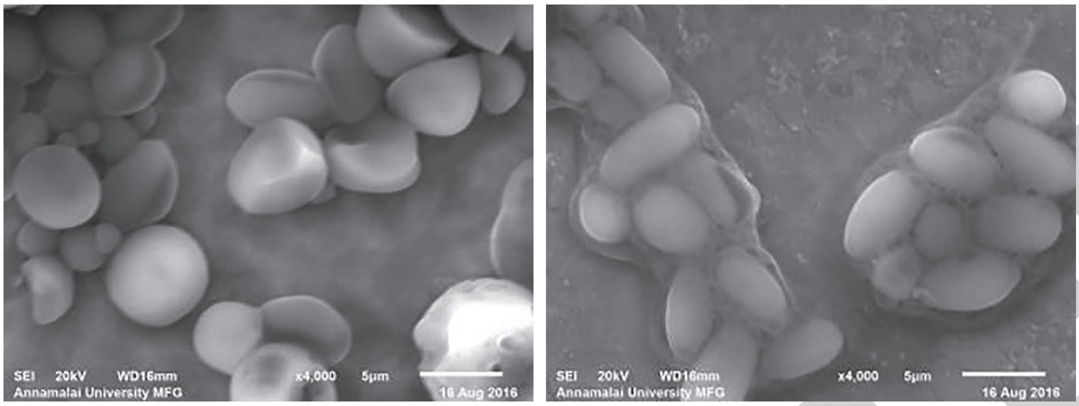

Figure 4: SEM image of 60 V and 75 V TNTA with pomegranate dye.

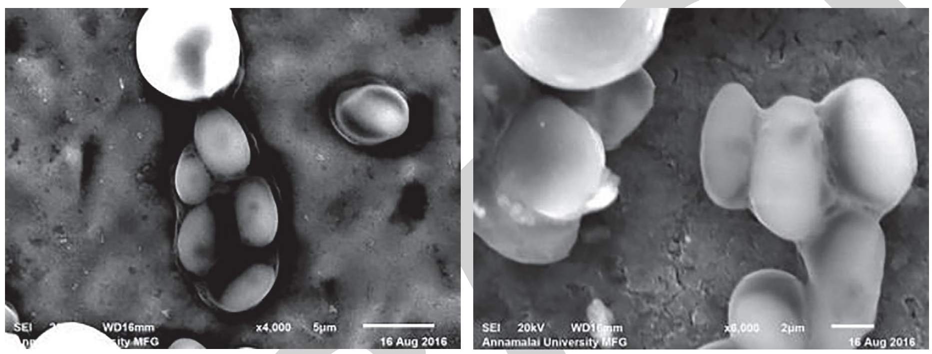

Figure 5: SEM image of 40–20 V and 50–25 V TNTA with pomegranate dye.

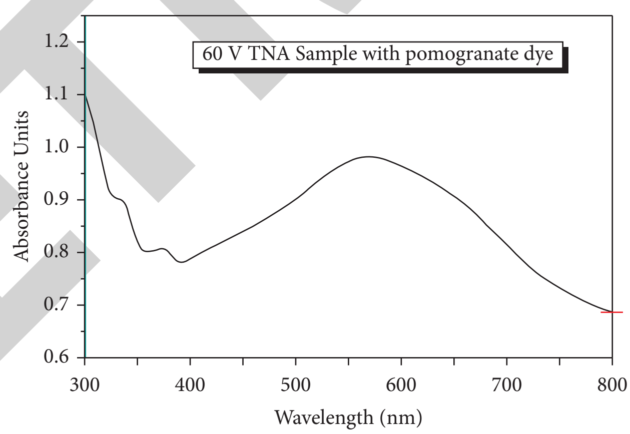

Figure 6: UV pattern of TNTA sample fabricated at 60 V with pomegranate dye.

shows the UV pattern of fourth TNTA sample with pomegranate dye. The natural dye showed a wide-ranging absorption performance peak value between 300 and 543 nm. The maximum absorption performance value is 543 nm. Table 1 shows the absorbance data of removed out dye from the pomegranate fruit using DI water.

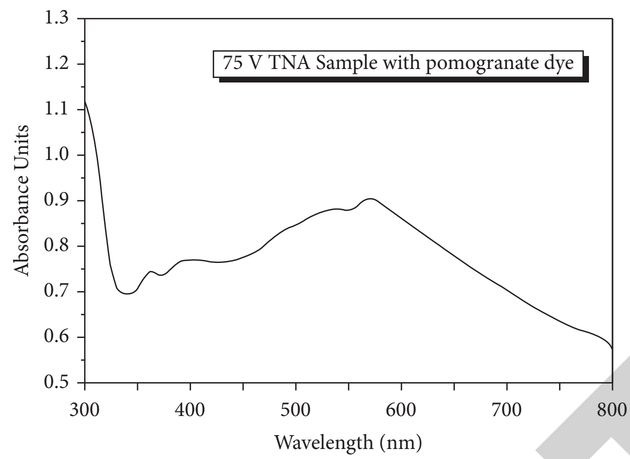

Figure 7: UV pattern of TNTA sample fabricated at 75 V with pomegranate dye.

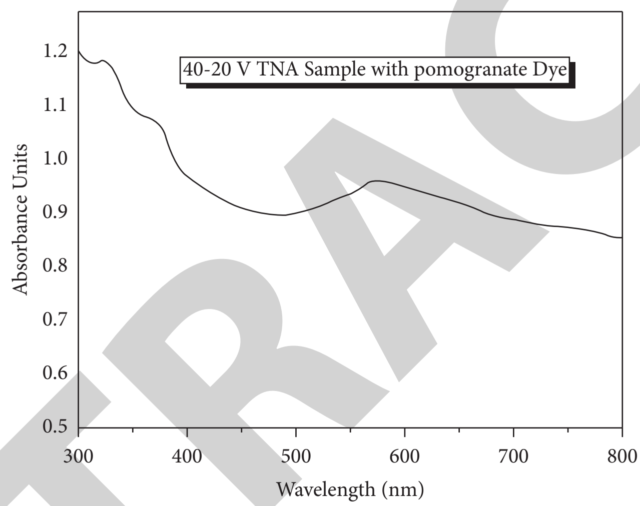

Figure 8: UV pattern of TNTA sample fabricated at 40–20 V with pomegranate dye.

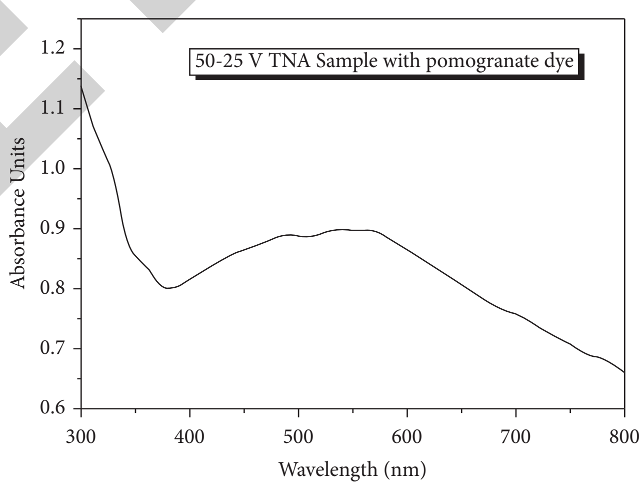

Figure 9: UV pattern of TNTA sample fabricated at 50–25 V with pomegranate dye.

Table 1: Absorbance of pomegranate dye.

SI. No.	Description	DC volt (V)	Visible light absorption range of sample with pomegranate dye
1	Sample 1	60	300 nm to 570 nm
2	Sample 2	75	300 nm to 574 nm
3	Sample 3	40–20	300 nm to 572 nm
4	Sample 4	50–25	300 nm to 543 nm

4. Conclusion

The natural dyes have enhanced the photon energy absorbing capacity of titanium nanotubes anode samples, and it was confirmed from the above UV-Visible Spectroscopy results. The UV-Spectroscopy test values of the natural dyes coated titanium nanotubes anode (TNTA) samples were examined. The natural dye showed a wide-ranging absorption performance peak between 300 and 574 nm for the second sample. The maximum absorption performance value is 574 nm. The natural dye showed a wide-ranging absorption performance peak between 300 and 572 nm for the third sample. The maximum absorption performance value is 572 nm. The natural dye will enhance the solar radiation absorption capability of the titanium nanotubes anode (TNTA) samples. Also, natural dyes will increase the electron flow in the dye-sensitized solar cell. It would enhance the dye-sensitized solar cell (DSSC) execution. Hence, the second sample and the third sample are the best samples, and it would be suitable for solar cell applications.

Data Availability

The data used to support the findings of this study are included within the article. Further data or information are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this article.

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