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Effect of Wavelength and Magnification in the Structural Image of Dyes for the Fabrication of Dye Sensitized Solar Cell

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Abstract
Analysis of the natural dyes as sensitizers in the fabrication in the dye sensitized solar cells has assisted in the ascertaining of its properties In this study, the structural analysis of the dyes were carried out where it was observed that the grain sizes varies directly proportional to the different magnifications and wavelength. At higher magnification and wavelength the grain sizes increases and vice versa.

Key words: *Magnification, Wavelength, dyes, grain size, sensitizer*

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I. Introduction

Dye sensitized solar cell is the third generation of solar cells which is preferred due to its low cost and accessibility. Natural dyes from plants act as sensitizers in the cell to capture the sun's intensity for light harvesting. In this study, emphasis will be on three known dyes and their structural characteristics where the relationship of the grain size with its wavelength and magnification will be visible. The three natural dyes from Laali stem bark, Tomato seed and Zobo leaves. These dyes are extracted and store in a beaker. Slides are deposited into the beakers containing the extracted dye solution for three days. The picture of the dyes is shown in figures 1.1, 1.2, 1.3 and figures 1.4 shows the deposition process. Thereafter these slides containing the thin film of the sensitizers are packaged for the structural analysis. This analysis was carried out in South Africa.

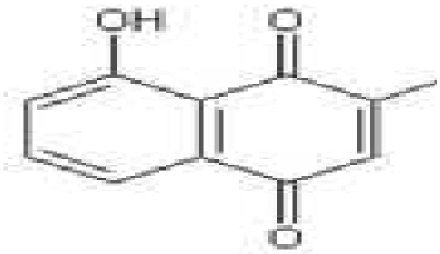


Figure 1.1: Picture of Laali stem bark and Chemical structure of isoplumbagin dye source: (Adenike *et al.* 2012)

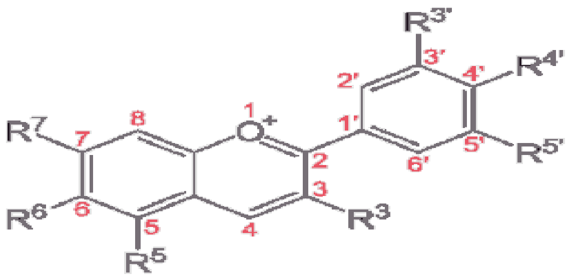


Figure 1.2: Picture of Zobo leaves (Anthocyanin)and Chemical structure of anthocyanin dye. Source: (Fernando, 2008)

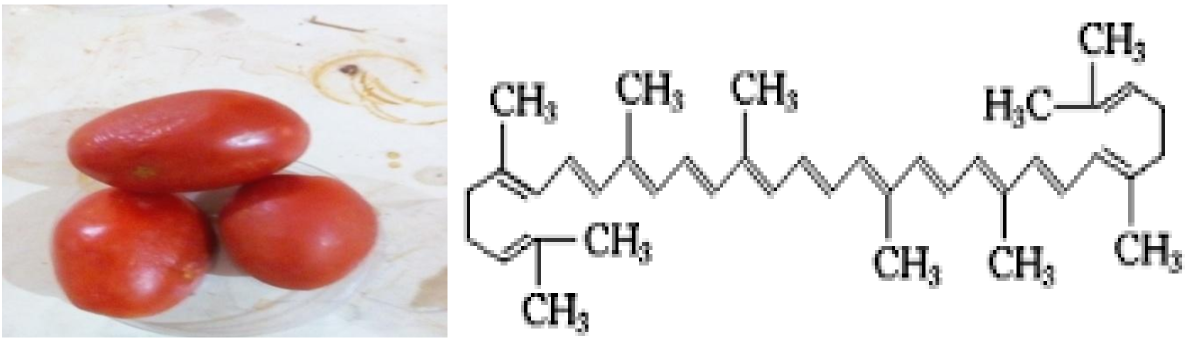
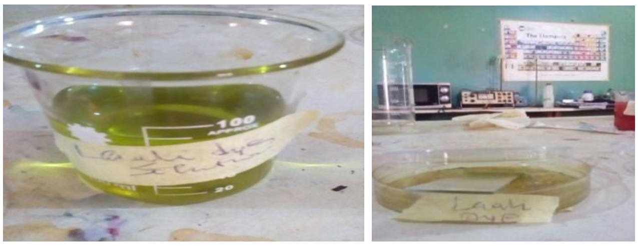


Figure 1.3: Picture of Tomatoe seed (Lycopene) and Chemical structure of lycopene dye source: (Kamiloglu, 2014)



(a) (b)

Figure 1.4a: Laali solution in a beaker

(a) (b)

Figure 1.4b: Zobo dye solution

(a) (b) (c) (d)

Figure 1.4c: Tomato seed dye solution

II. Materials/Method

The materials are glass slide. Three natural dyes from Laali stem bark, zobo and tomato, mortars, sieve, beakers, ultrasonic. Acetone, ethanol and distilled water

The glass was first treated to remove impurities as follows: the slides are placed in a beaker containing Acetone solution for sometime then rinsed with distilled water and finally placed inside an ultrasonic machine for 15 minutes thereafter placed in the oven dryer and ready for use.

Next the dyes were extracted from the three plants one after the other. The 10.30g of laali stem bark was carefully crushed inside a mortar and soaked in 100ml of ethanol over night. Thereafter was filtered into a beaker and a greenish colour was observed and immediately a glass slide was inserted using the chemical bath deposition CBD method as shown in figure 1.4a.

100ml equal volume of ethanol and distilled water was used to soak 20g of zobo leaves overnight and then filtered into a beaker a dark wine colour was observed. Finally a glass slide was inserted into the beaker as shown in figure 1.4b.

23.80g of tomato fruits were crushed and soaked in 20 ml of ethanol overnight, a reddish colour observed after flitting it into the beaker. A glass slide was inserted into the solution. These slides were inside the dye solution for three days after which a visible thin film of these natural dyes were visible. The structural analysis were then carried out in order to observe the relation between wavelength , magnification and their grain sizes.

Characterization (Analysis) procedure

The scanning Electroscope Microscope (SEM) characterization of the dyes and their composite systems and finally the fabricated dye sensitized solar cell will be discussed in detail as follows:
Structural characterization (Scanning Electroscope Microscope)

Scanning electron microscopy

Electron microscopes create images of materials by directing a high-energy beam of electrons at the sample. They two of its kind-Transmission Electron Microscopes (TEM) and Scanning Electron Microscope (SEM), but in this study only the SEM equipment were used. With a focused beam of electron the specimen undergoes a scan. The scattered electrons are detected and used to form an image. These microscopes are used to learn about external structure, chemical composition, crystalline structure and orientation of materials and are particularly useful for seeing nanopartcles and nano composites: where Images showing a large depth of field, yielding a three- dimensional appearances, with magnification: up to six order of magnitude,(between 10 to 500,000 tonnes) resolution from less than 1 nm to 20 nm (depending on the instrument specification).

Lu-Ting *et al.* (2012) carried out a study using *Photoanode of Dye-Sensitized Solar Cells based on a ZnO/TiO_2 Composite* where the ZnOs used in the composite films were ZnO tetrapods prepared via evaporation and ZnO nanorods obtained via hydrothermal growth and fabricated on a transparent conductive glass substrate using different techniques including electrophoretic deposition, screen printing, and colloidal spray. The structural and morphological characterizations of the thin composite films were carried out using Scanning electron microscope (SEM)

III. Results and Discussion

The following figure 1.5a, 1.5b and 1.5c shows the scanning electron microscope of the three natural dyes Laali, Tomato and Zobo at 100kx magnification and 100nm wavelength while figure 1.6a, 1.6b and 1.6c shows at 5kx and $1\,\mu$m wavelength. Likewise, figures 1.7a, 1.7b and 1.7c show at 1kx and 10 μm magnifications and wavelengths. The subsequent figures shows reduced magnification constant wavelength as in figure 1.8a,b,c at 50kx and 100nm and reduced magnification and increased wavelength as seen in figure 1.9a,b,c at 25kx and 200nm.

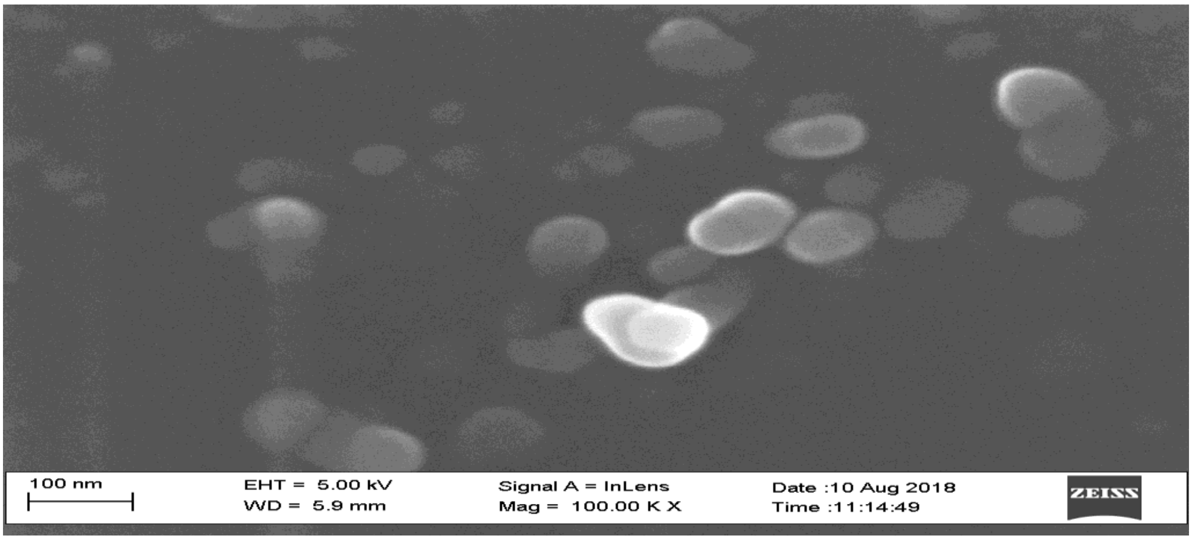


Figure 1.5a: SEM of Laali dye at magnification 100kx for 100nm wavelength

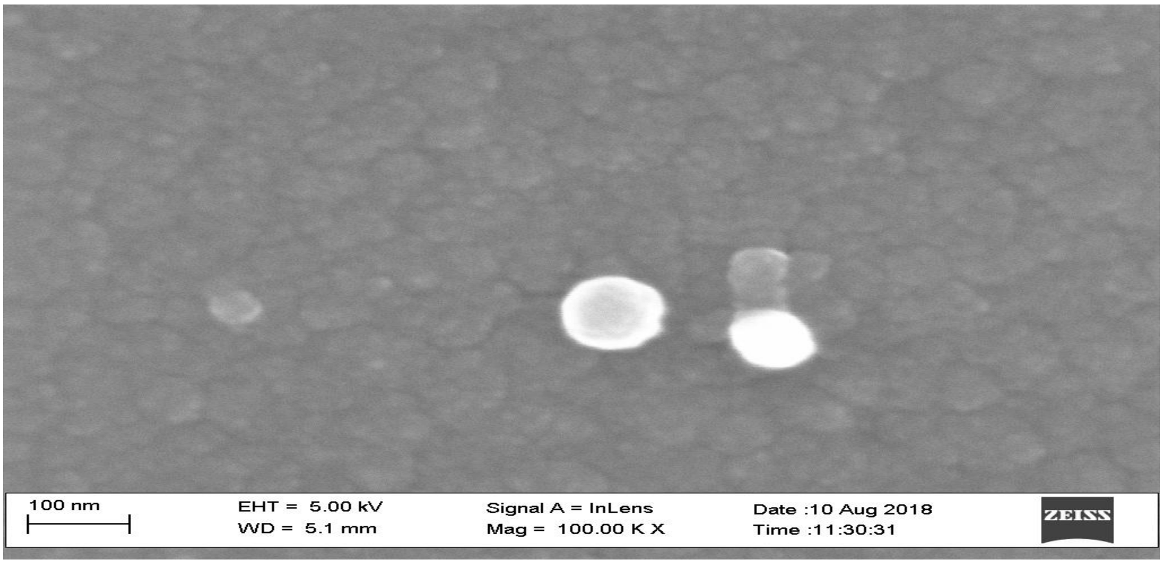


Figure 1.5b: SEM of Zobo dye at magnification 100kx for 100 nm wavelengths

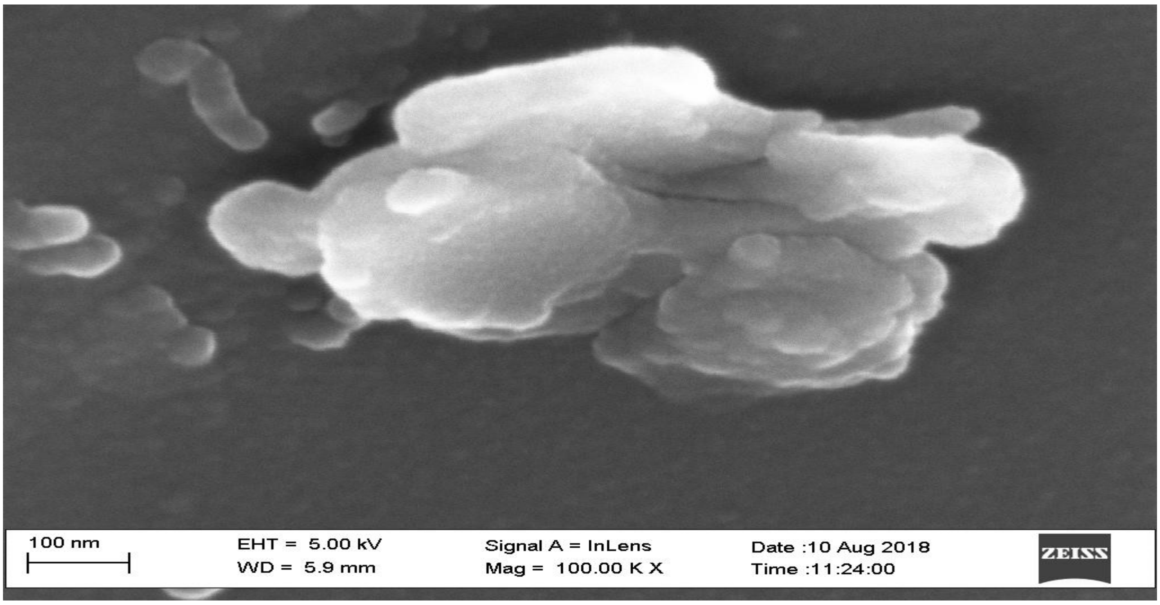


Figure 1.5c: SEM of Tomato dye at magnification100kx for 100nm wavelength

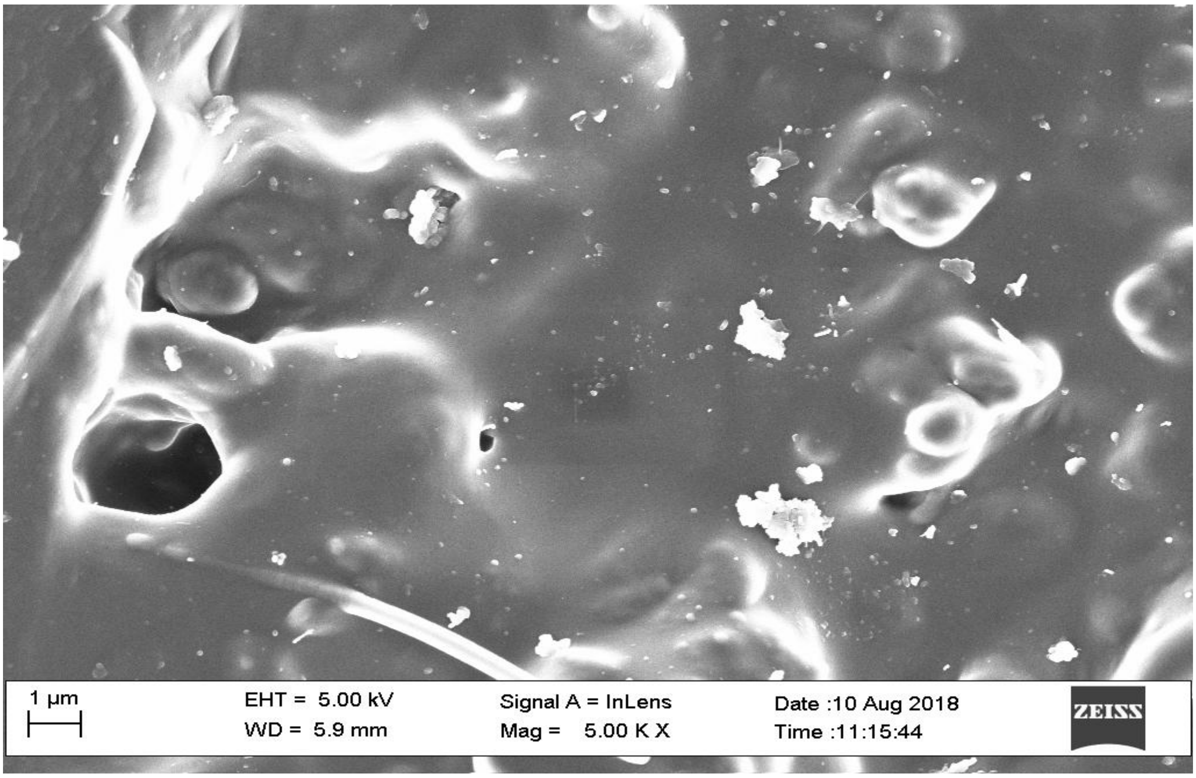


Figure 1.6a: SEM of Laali dye at magnification 5kx for wavelength 1 μ m

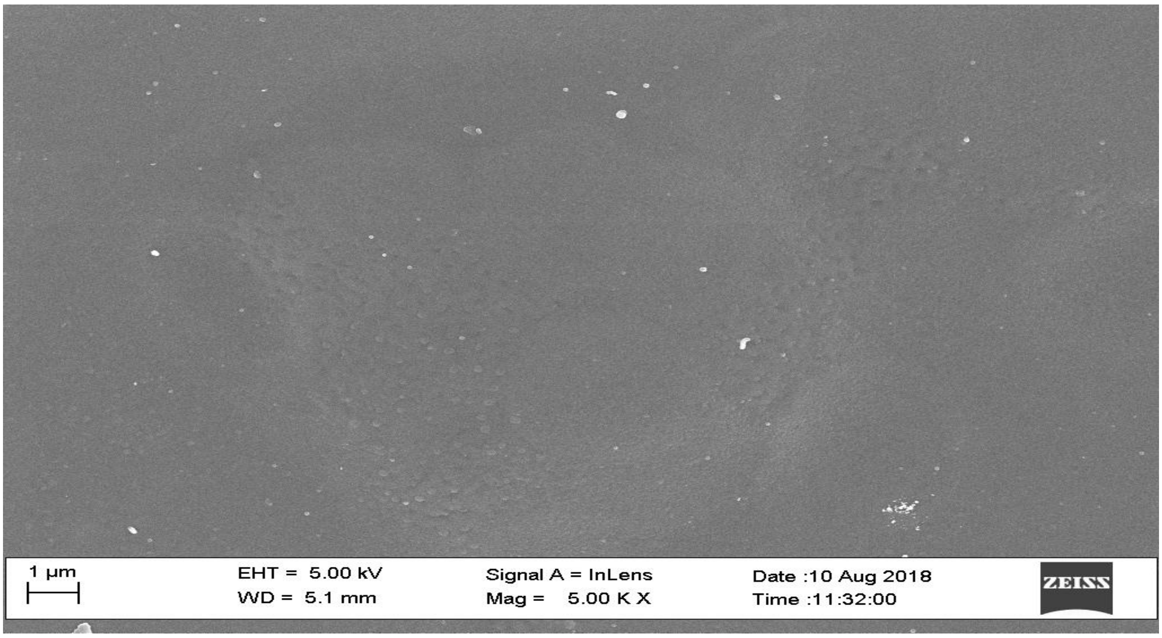


Figure 1.6b: SEM of Zobo dye at magnification 5kx for 1 μ m wavelength

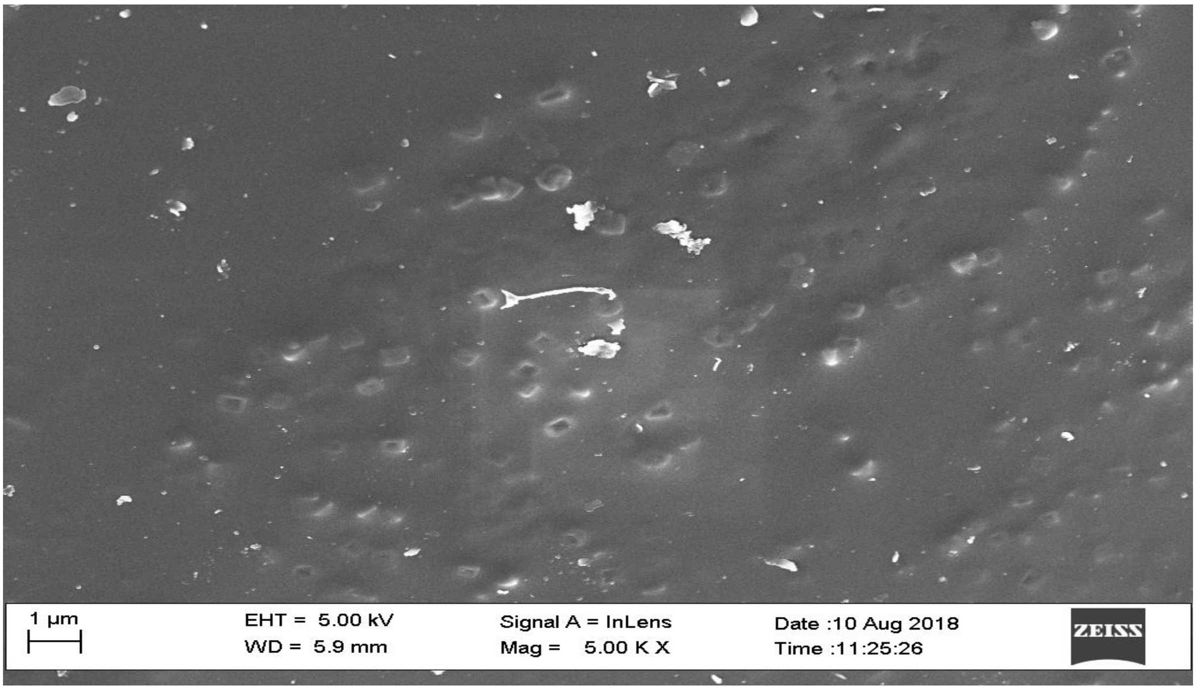


Figure 1.6c: SEM of Tomato dye at magnification 5kx for 1 μ m wavelength

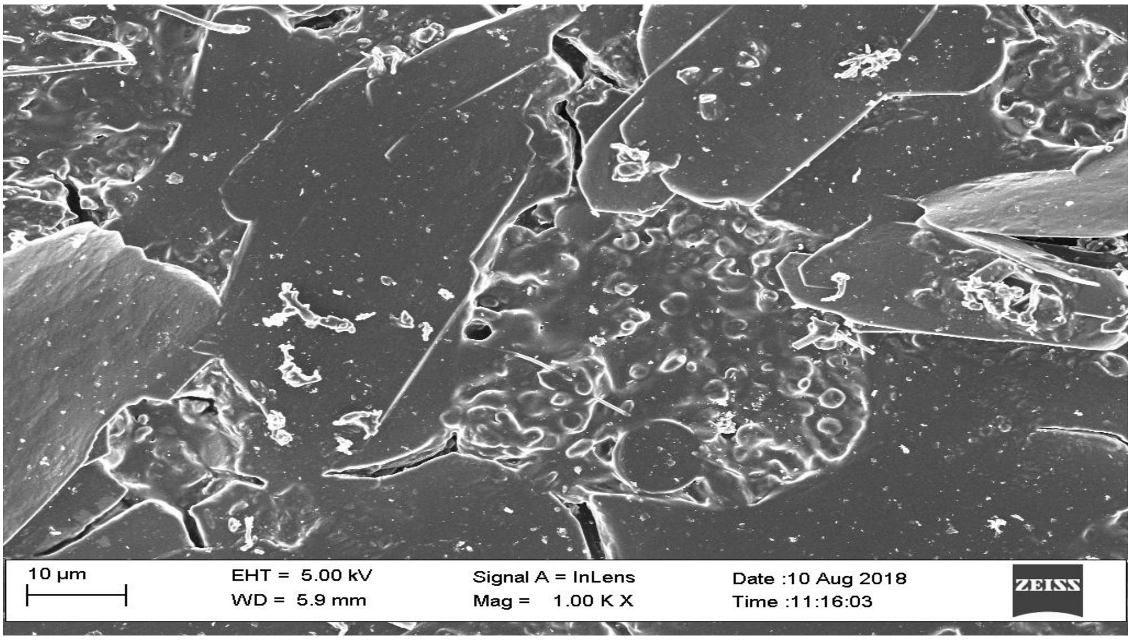


Figure 1.7a: SEM of Laali dye at magnification 1kx for 10 μ m wavelength

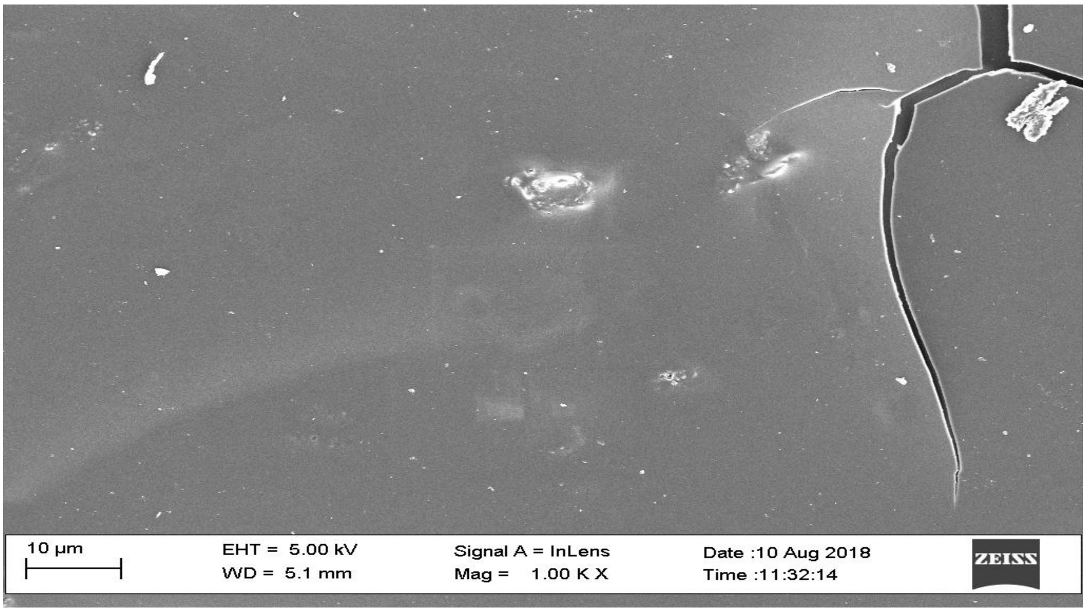


Figure 1.7b: SEM of Zobo dye at magnification 1kx for 10 μ m wavelength

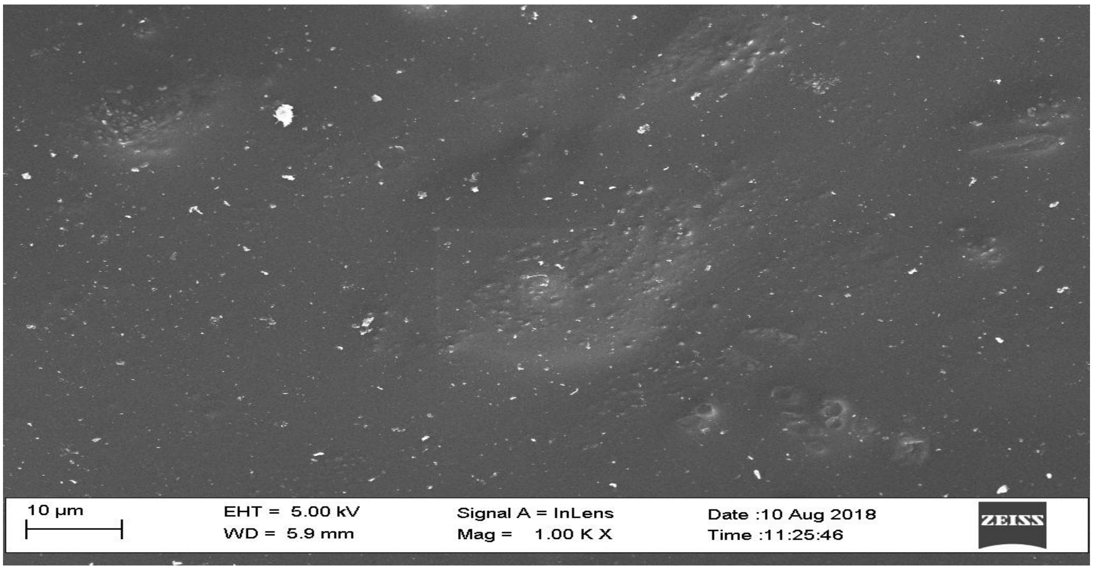


Figure 1.7c: SEM of Tomato dye at magnification1kx for 10 μ m wavelength

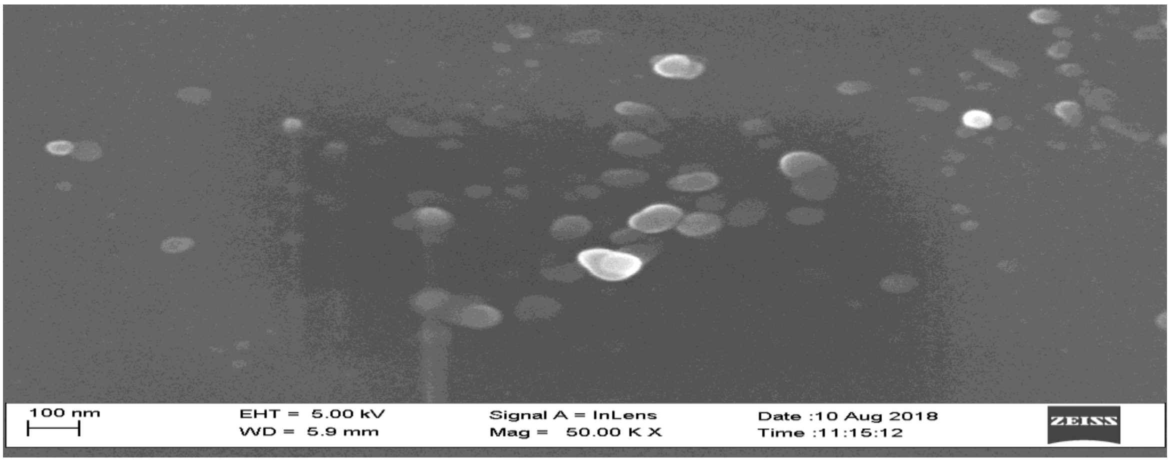


Figure 1.8a: SEM of Laali dye at magnification of 50kx for wavelength 100nm

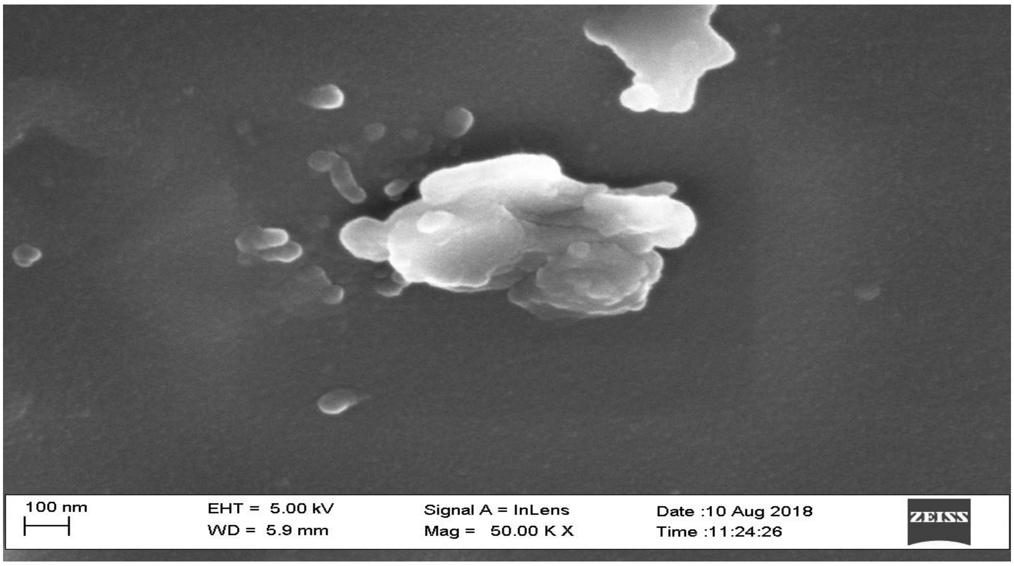


Figure 1.8b: SEM of Tomato dye at magnification 50kx for 100nm wavelength

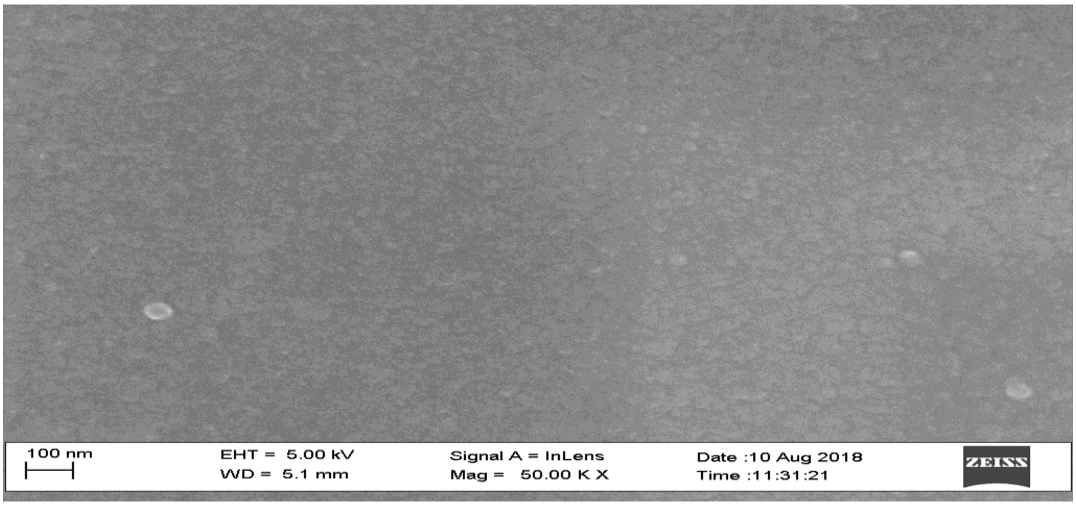


Figure 1.8c: SEM of Zobo dye at magnification 50kx for 100 nm wavelength

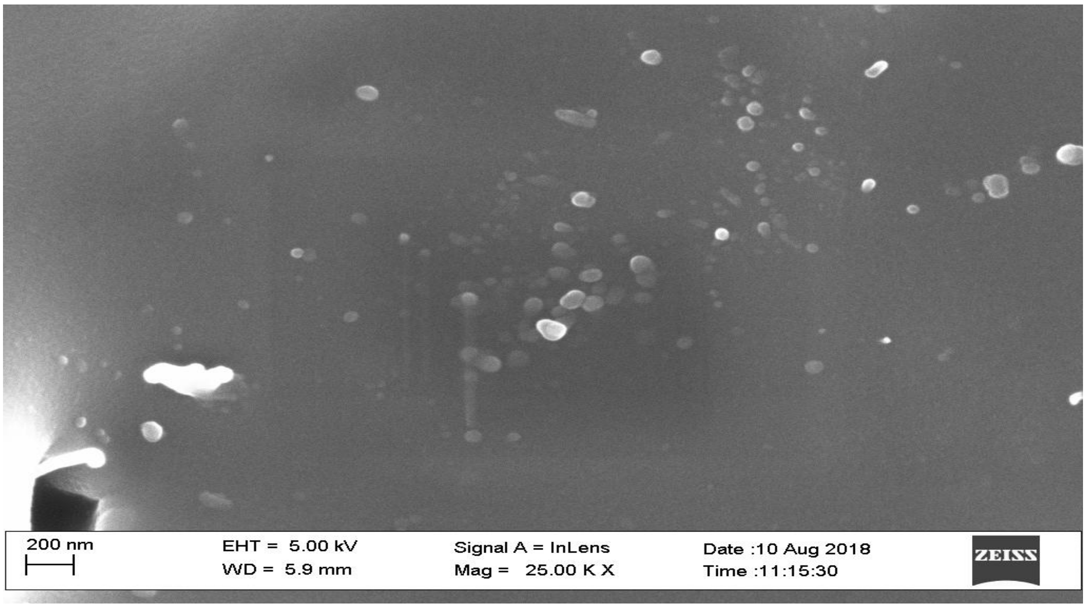


Figure 1.9a: SEM of Laali dye at magnification 25kx for wavelength 200nm

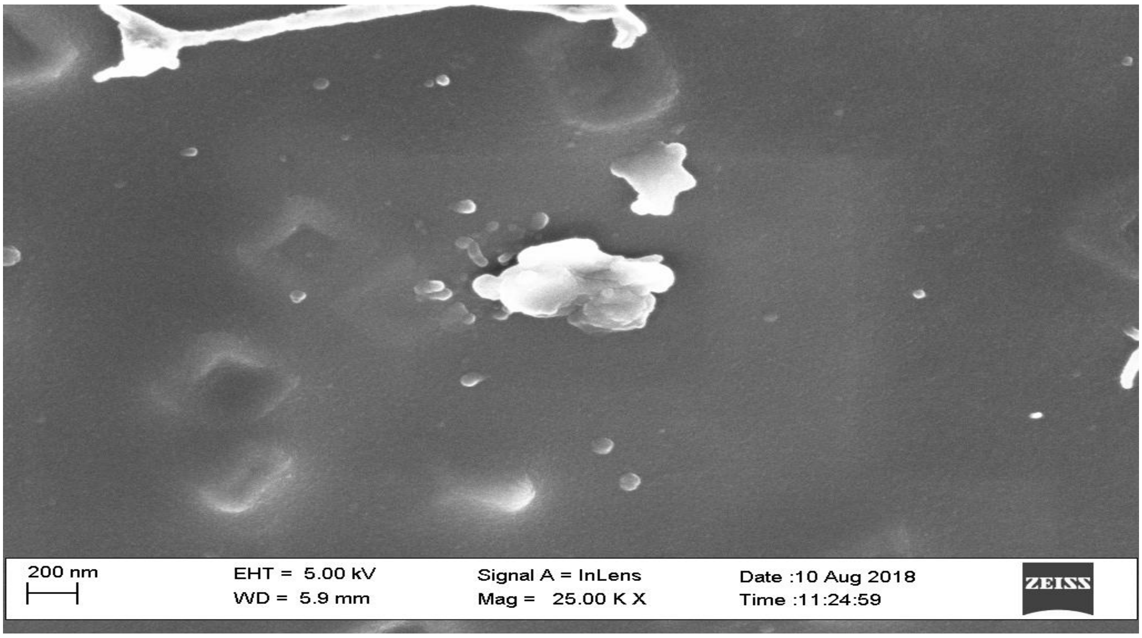


Figure 1.9b: SEM of Tomato dye at magnification 25kx for 200nm wavelength

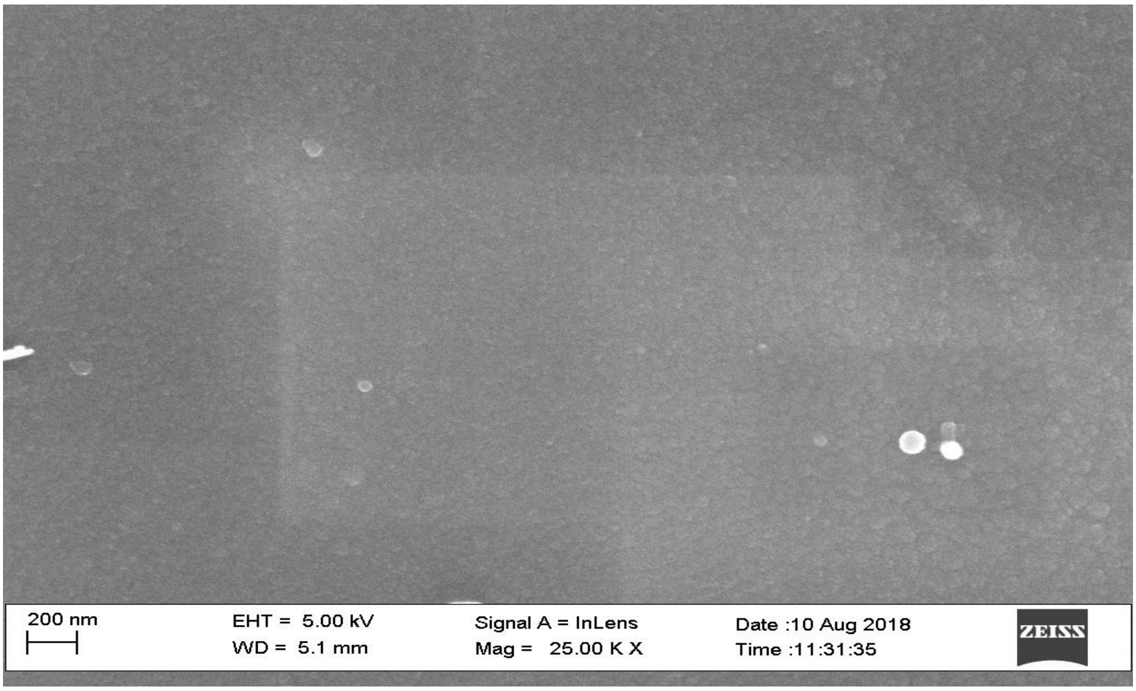


Figure 1.9c: SEM of Zobo dye at magnification 25kx for 200 nm wavelengths

IV. Discussion

Laali image increased with high magnification and visibility clearer (100 kx and 100nm wavelength) as shown in figure 1.5a. As the magnification reduces the grain size are scattered evenly as shown in figures 1.6a, 1.7a and 1.8a respectively. Reduced magnification and constant wavelength the grain decreases in size but not in quantity as in figures 1.5a, b, c and 1.8a, b, c of the three dyes. Reduced magnification and increased wavelength the grain sizes decreases and the images more and less visible. As seen in figure 1.8a,b,c and figure 1.9a,b,c respectively.

Zobo dye showed two big image of the particle and reduces in size as the magnification and wavelength reduces as shown in figures 1.5b, 1.6b and 1.6c for 100kx and 100nm wavelength, 5kx and 1 μm, and 1kx and 10 μm wavelength.

SEM for tomato dye showed a large image at100kx magnification and 100nm wavelength but reduces in grain size as the magnification and wavelength decreases.

V. Conclusion

From the structural analysis it is obvious that grain size is directly proportional to the different magnifications and wavelength. As wavelength and magnification increases the grain sizes of the dyes are enlarged which can enhance the capture of the sun's intensity for light harvesting.

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