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Deposition of Colloidal Titanium and Copper Nanoparticles by Pulsed Laser Ablation on Si Solar Cell to Increase the Efficiency

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Abstract— **In this work, we had done laser removal of the accompanying materials; titanium and copper focuses in deionized water to combine titanium and copper oxides nano-particles and saved on silicon sunlight based cell to expand the proficiency of the Si sun based cell. The surface morphology of the stores materials had been examined by utilizing Atomic Force Microscope (AFM). The purity of powders Ti and Cu were researched utilizing X-beam Florence's (XRF). The optical properties of incorporated NPs were considered utilizing UV-VIS spectroscopy. The dark and illuminated I-V characteristics of Si solar cell deposited with TiO_2 and CuO NPs have been studied before and after spin coating. The best junction was obtained for TiO2 NPs. The Fourier transform infrared spectroscopy result shows that there are absorption bands between 400-1000 cm^{-1}.**

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***Index Terms*— Laser removal; TiO_2 NPs; Copper metal powder**

I. INTRODUCTION

LASER removal represents emotional laser material interaction wonder . The measure of mass removed was relying upon the laser parameters, for example, beat term, energy, wavelength, target properties and the encompassing environment [1, 2]. The laser evacuation process is described as the system of target material release from its surface by using ultra-short beats of laser [3], or the method of enlightens a solid concentration from surface all through course of action of ultra-thick plasma of a high temperature in the midst of focusing of amazingly short beat of length 9 nm is in like manner portrayed as laser expulsion plan [4]. The beat laser removal in fluid framed when an objective is inundated in a fluid. This strategy (as known as scattering technique) is investigated as a prospective top-down method for nanoparticles readiness of metals [5-9]. This procedure PLAL is another materials handling method that can offer lower cost and basic approach to perform. Advance, it considered as a one of a kind and great strategy for orchestrating both of NPs [6]. TiO_2 is a fascinating class of inorganic solids in an extensive variety of basic and high system applications because of its wide application in the photo catalysis, optical materials, what's more, shading honed sun based cell, and lithium-molecule batteries fields. CuO is one of the competitor materials. The components of copper oxide semiconductors is high optical.

The aim of this paper is to fabricate a new nanomaterial that can be added to the photovoltaic modules to enhance its performance.

II. EXPERIMENTAL WORK

Titanium and copper powders with work 325 (particle appraise less 44 µm) were crushed with 20 Tons by using water fueled press to shape pellet with width of 16 mm , weight 3g and for 5 minute press. The thickness 4mm and 3mm to titanium and copper powders independently depended on upon the thickness of the titanium and copper powders as showed up in Figs. (1 & 2).

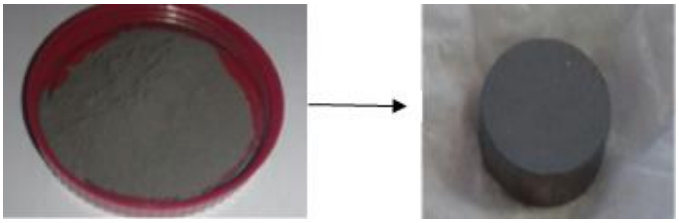

Fig. (1): a) Titanium metal powder b) Titanium powder after pressed with 20 Tons by using hydraulic press.

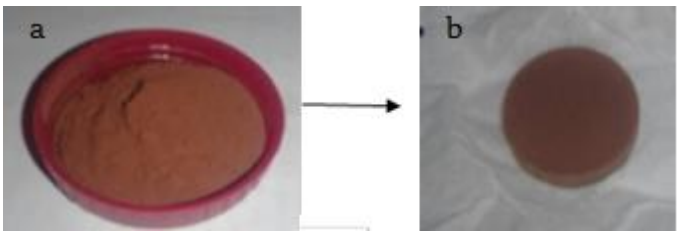

Fig. (2): a) Copper metal powder b) Copper powder after pressed with 20 Tons by using hydraulic press.

Faultless titanium and copper targets were expelled in deionized water with liquid significance 2 ml, λ=1064 nm, most outrageous pulse essentialness used for all the metal targets 100 mJ, and the amount of laser shots associated for all

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the metal targets 150 pulse. The column laser was revolved around the goals by point of convergence focal length 80 mm. The emphasis rate associated for the metal targets 1Hz and 4Hz independently. Maintenance spectra of the nanoparticles plan were measured by UV-VIS twofold column spectrophotometer. The titanium and copper nanoparticles were depicted by atomic constrain microscopy (AFM) is expected on AA 3000 Scanning test amplifying focal point Angstrom Advanced Inc. Turn covering has been used to put away uniform 8 drops from titanium oxide and copper oxide nanoparticles course of action on to wafers Si sun based cells. The titanium oxide and copper oxide nanoparticles course of action were dab at turn speed of 1000 rmp/min for 1min. turn covering pulls the nanoparticles uniform on surface Si sun controlled cells from dabs and scatters game plan. The current – voltage estimations of TiO2 and CuO NPs Si sun fueled cell was set up at different examination dull and illumination condition. To finish these estimations, progressed multimeter, decade resistance box (5k ohm) and DC coordinated power supply were used. In diminish condition, current of Si sun based cell before kept and after spared TiO2 and CuO on Si sun based cell stretched out from (0 to 1 V) with a phase of 0.2 V were finished. Comparable estimations were repeated current condition at light power 100 mW/cm^2 to gage the I-V trademark under lighting up condition.

III. Results and Discussion

The titanium and copper metals powders rate purities were test by XRF which was a diagnostic strategy to decide the compound organization of a wide range of materials and it's found the rate titanium and copper metals powders meet 94.09% and 97.26% separately find in Tables (1) and (2) in addition to Figures (3) and (4).

Table 1: titanium metal powder test by XRF.

No.	Element	Percentage %
1	Ti	94.09
2	Al	4.24
3	V	1.06
4	Cu	0.39
5	Si	0.15
6	Mn	0.06
7	Pb	0.011

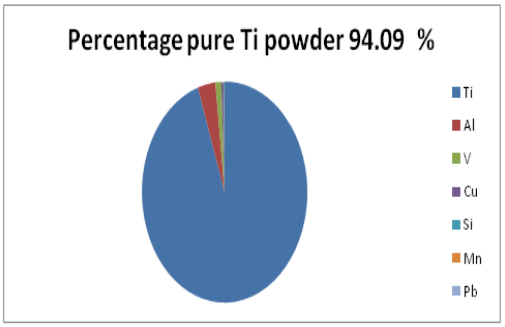

Fig. (3): Percentage pure copper metal powder.

Table 2: copper metal powder test by XRF.

No.	Element	Percentage %
1	Cu	97.26
2	Al	1.06
3	Pb	0.87
4	Si	0.31
5	P	0.219
6	S	0.154
7	Cr	0.12

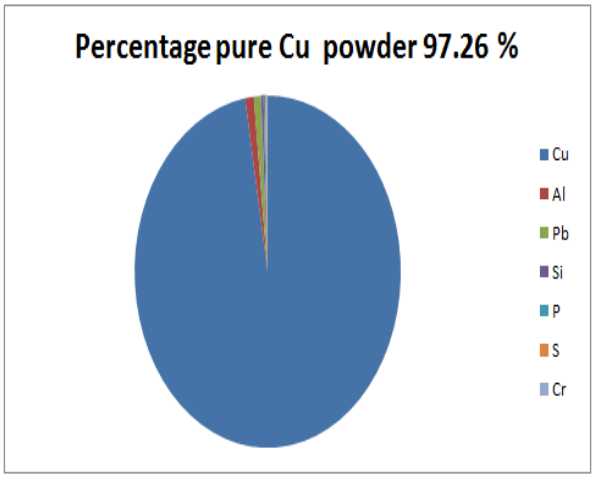

Fig. (4): Percentage pure copper metal powder.

The photograph of the Ti target before and after laser ablation are observed in Fig.(5) a, b.

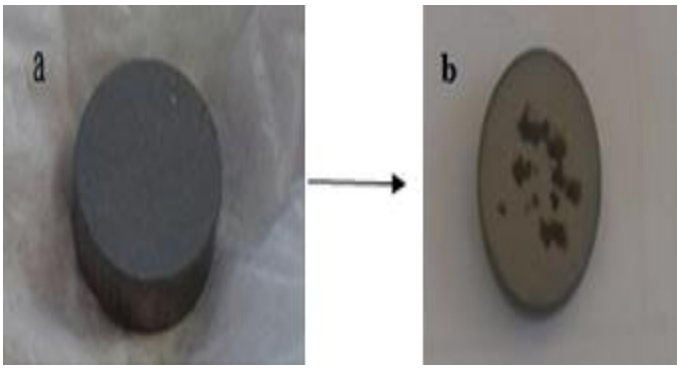

Fig. (5): a)Ti target b) Ti target after laser ablation.

Fig. (6): Demonstrated pictures of AFM for TiO2 with zone (size=2015nm X2031 nm) and capacity logical (pixels=504, 508). Fig. (6a) is AFM picture in three measurements (3D), it clarifies auxiliary shape for grains, Fig. (6b) is AFM picture in two measurements (2D), it discovered Average Roughness is 0.624nm and RMS (Root mean square) is 0.728nm and Fig. (6c) speaks to particles circulation, where grains number is 196.

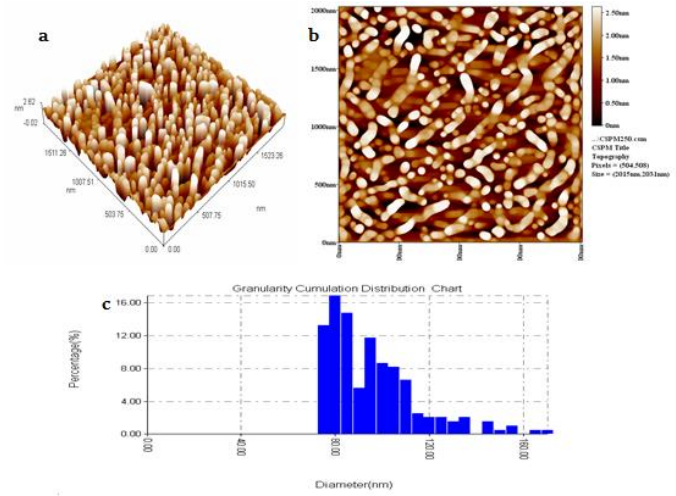

Fig. (6): AFM for titanium oxide.

Figure (7) outlines the FTIR spectra of TiO2 NPs orchestrated at number of laser pulse 150. In this figure it can see the maintenance peaks at (495.72 cm-1, 513.08 cm-1, 594.10 cm-1, 705.97 cm-1) which contrasting with TiO2. The additional zeniths were found in the district of 1100-1700 cm-1 demonstrating the closeness of physisorbed water. The peak at (3450.77 cm-1) has a place with O-H bond.

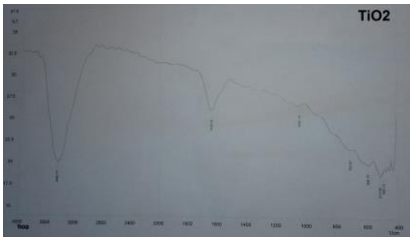

Fig.(7): FTIR spectra of the TiO_2 NPs prepared at number laser pulses in deionized water 150 pulse.

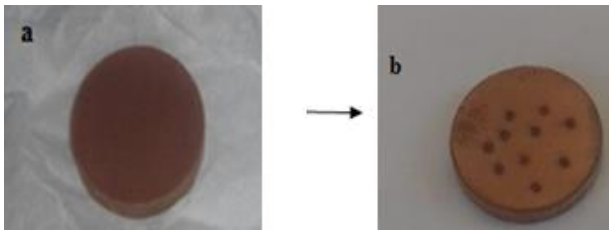

Fig. (8): a) Cu target b) Cu target after laser ablation.

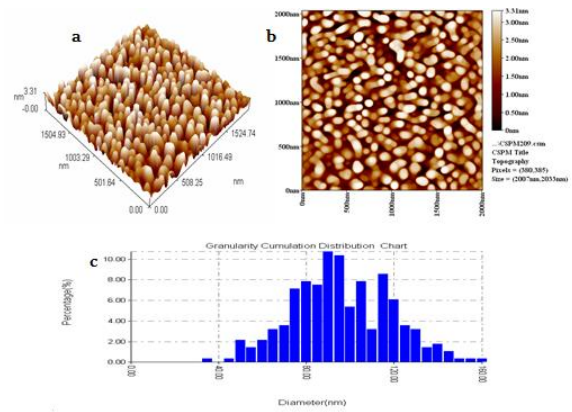

Fig. (9): AFM for copper oxide

Figure (10) depicts the FTIR spectra of CuO NPs masterminded at number of laser pulse 150. In this figures it can see the absorption tops at (414.71 cm-1, 428.21 cm-1, 482.22 cm-1, 501.51 cm-1, 513.08 cm-1, 553.59 cm-1, 603.74cm-1) which identifying with CuO. The additional apexes were found in the zone of 1100-1700 cm-1 demonstrating the proximity of physisorbed water. The top at (3435.34 cm-1) have a place with O-H bond.

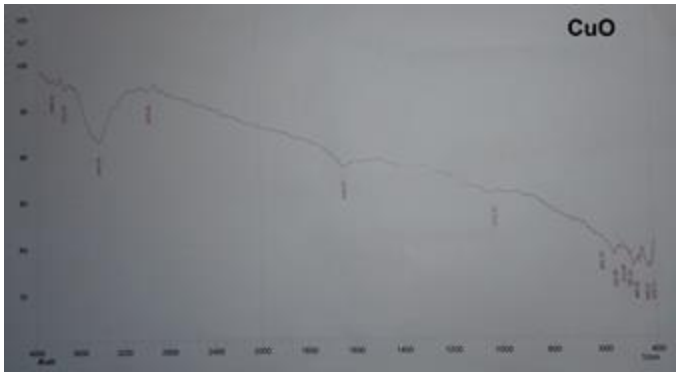

Fig. (10): FTIR spectra of the CuO NPs prepared at number laser pulses in deionized water 150 pulse.

In Figures (11) , (12) demonstrates the maintenance spectra of TiO2 and CuO nanoparticles suspended in deionized water orchestrated at different number of laser heartbeats 50,100 and 150. The ingestion spectra of titanium oxide and copper oxide nanoparticles colloidal shows far reaching bunch and have most lifted zeniths osmosis centered at 380nm, 365nm independently.

The digestion spectra of TiO2 and CuO nanoparticles colloidal exhibited a move in maintenance best as the amount of laser heartbeats move. The watched maintenance beat as the amount of laser heartbeats contrasts.

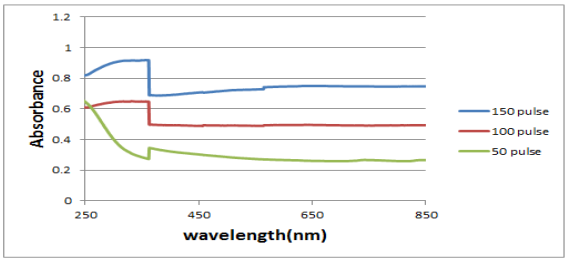

Fig. (11): UV-VIS spectra of titanium oxide nanoparticles colloidal in deionized water synthesized at different pulses of laser (50, 100 and 150) respectively

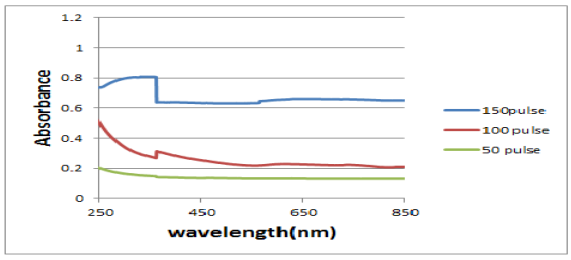

Fig. (12): UV-VIS spectra of copper oxide nanoparticles colloidal in deionized water synthesized at different pulses of laser (50, 100 and 150) respectively.

The optical band crevice of nano-materials is reliant on the molecule measure .It increments at the molecule estimate diminish. The optical band hole or vitality hole (Eg) of TiO_2 and CuO NPs colloidal arrangement at laser beats 150 has been controlled by the eq.(1). The wavelength most extreme of TiO2 and CuO NPs decided from UV-VIS range. Find in Table 3.

$Eg = 1239.8/ \lambda_{max}$ ..... (1)

Where λ (nm) is the wavelength max.

Table 3: Measured bandgap energy of synthesized TiO_2 and CuO nanoparticles at laser pulse 150, (Bg-Bandgap value, λmax-cutt-off wavelength).

Nano material	λ_{max} (nm)	Bg (ev)
Titanium oxide	380	3.262
Copper oxide	365	3.396

The photovoltaic execution is showed up in Fig. (13) in dull and Fig. (14) in lit up (100 mw/cm^2) can be focus from the cell beforehand, then afterward kept titanium oxide and copper oxide NPs outline this twists we procured the open circuit voltage (Voc) and short out current thickness (Jsc). The higher short out current thickness may be by virtue of the photons is a result of bearers that are made some place down in the weight of the silicon.

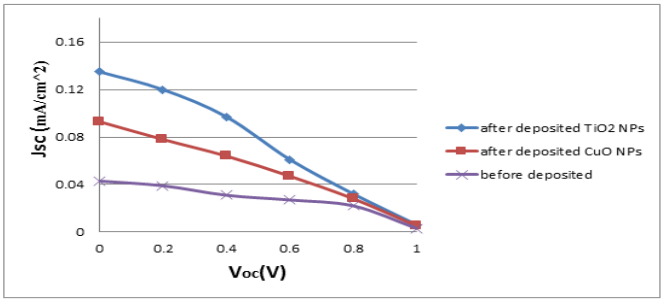

Fig. (13): The photovoltaic performance in dark before deposited and after deposited titanium oxide and copper oxide NPs

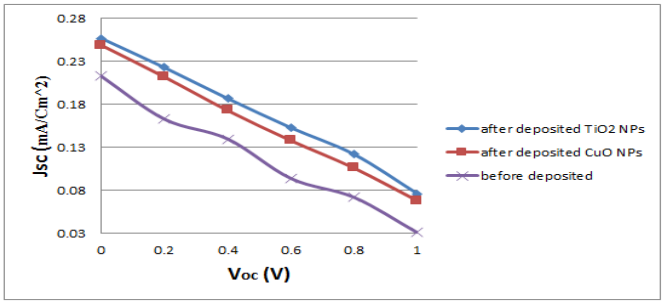

Fig. (14): The photovoltaic performance in illuminated (100mw/cm^2) before deposited and after deposited Titanium oxide and Copper oxide NPs.

IV. Conclusion

The nanoparticles size could be controlled by legitimate determination of the laser parameters. The particles estimate distance across increment with increment laser heartbeats. Nuclear drive magnifying lens (AFM) examination demonstrated that titanium oxide and copper oxide nanoparticles have root mean square of surface harshness (0.728 nm, 0.882 nm) separately and molecule estimate dissemination of titanium and copper were (75-170) nm, (35-160) nm individually after laser ablation. The TiO_2 NPs gave the best dull and lit up I-V and productivity qualities took after by CuO came about the optical band hole of nanomaterials was subject to the molecule measure .it increments at the molecule measure diminishes. The NPs was trapping light on the surface of the SSC. The ingestion of light was not key for the nanoparticle; rather, it was basic for the SSC. The nanoparticle was extended in size, and then the diffusing cross-range gets the chance to be greater.

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