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Morphological and Optical Properties of Cu_2O/ 2-D Silicon Photonic Structure for Sensing Applications

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Abstract*—In this paper the porous silicon (PS) was fabricated by photo electrochemical technique. Deposition of Cu_2O thin film on nanocrystal-lines silicon by pulse laser was deposited by using the Tattoo removal laser, 2J and 1064 nm wavelength, and high purity Cu target at 350K in static air. Surface morphology and Photoluminescence for PS and Cu_2O/Ps were investigated.*

Index Terms*— porous Silicon, Cu_2O, Copper Oxide, Optical properties, structural properties.*

I. INTRODUCTION

Copper oxide enters in many applications, such as solar cell applications because of its excellent structural properties [1, 2]. The importance of copper oxide in many applications is due to its excellent properties as ease of fabrication, availability and low emission, high absorption coefficient and cost-effective material [3, 4].

Copper oxides are classified as semiconductor materials and can be divided into three oxides known as cuprite (Cu_2O) with band gap (2.1 to 2.6 eV), tenorite (CuO) with band gap (1.21 to 1.51eV) and Cu_2O_3 with band-gap (1.4 to 2.5 eV) [5,6].To form Copper Oxides thin films were used in various techniques as RF magnetron sputtering, thermal oxidation, spray pyrolysis [7-9].

In this paper, it was used pulsed laser deposition (PLD) technique to form Cu_2O thin film on porous silicon substrate. The morphological surface of the grown thin film was tested by using AFM and the photoluminescence analysis techniques.

II. EXPERIMENTAL WORK

A square shaped of n-type silicon with (111) orientation has been utilized to form nanocrystal porous silicon (PS) by using photo-electrochemical etching technique.

A (1.06 μm) Nd-YAG laser was used to evaporate pure copper metal on the surface of (PS) substrate to forming nanostructure thin film of Cu_2O by pulse laser deposition at (350 K) and (10^{-3}) as vacuum ambient with oxygen gas pumping (50 mbar), the pure copper was converted to copper oxide and deposited on the PS.

III. RESULTS AND DISCUSSION

From the image of AFM in *Fig (1)a*, it can be seen that the surface morphology of (PS) appears as good network of small voids called pores with thin walls called Nano-crystallites separated between the pores. When the light ray reflected from one side inside the hall surface to hit another, this leads to an improvement to the probability of absorption, and decrease of the reflection compared with silicon surface [10].

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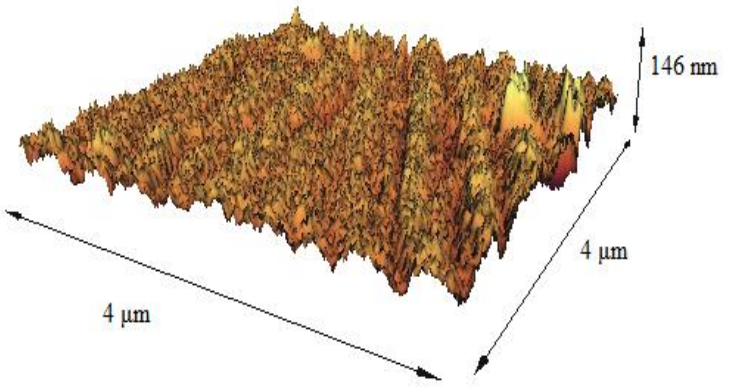
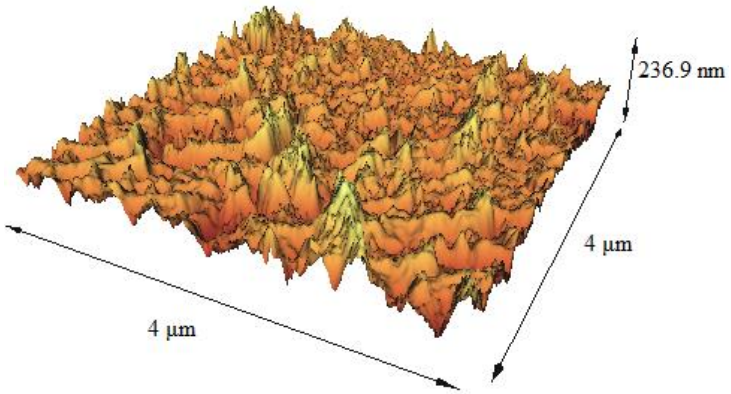
Regarding the multilayer structure of (Cu_2O/Ps) in *Fig (1)b*, the increase in the Nano-meter size such as in table (I) because of the increasing in Nano-structure oxide film results from the pulsed laser deposition of the pure copper. Also it could be known that the regular distribution to porous surface results from additional Nano-structure oxide thin film.

TABLE (I) GRAIN SIZE OF NANOPARTICLES

PS layer	Cu_2O/Ps
33.94 nm	38.917 nm



(A)



(B)

FIGURE (1) THE AFM OF (A) PS (B) Cu_2O/PS

Fig (2) shows the photoluminescence of PS and Cu_2O/PS NPs at room temperature that studied at excitation wavelength of 450 to 750 nm. The PL emission was found in two positions and in intensity both between PS and Cu_2O/PS NPs samples with peak lying between 505.97 and 617.9 nm. An emission peak at 505.97 nm gives a 2.451 eV as band gap that detected for Cu_2O NPs synthesised by PLD. The origin of emission peak at 505.9 nm can be ascribed to band gap transitions within Cu_2O NPs [11].

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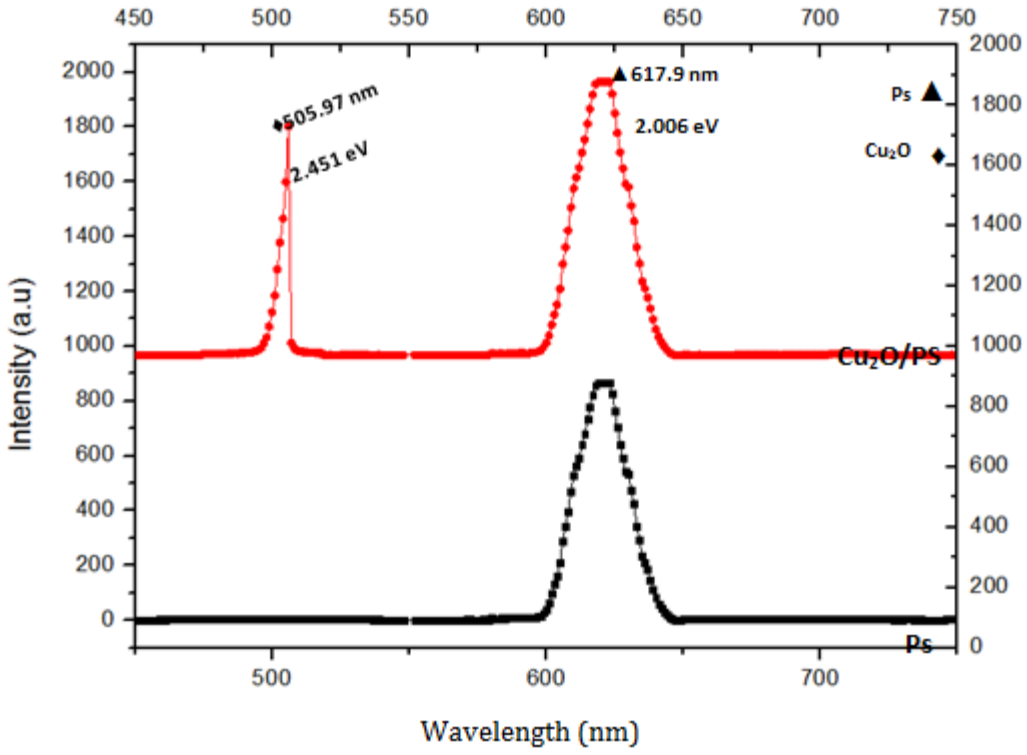

FIGURE (2) PL SPECTRA AT ROOM TEMPERATURE.

IV. CONCLUSION

Cu_2O thin film, which was grown on nanocrystal-lines silicon (PS) by pulse laser, was deposited to study the morphology (AFM) and photoluminescence analyses (PL). The obtained results show that the grain size increases from (33.94 nm) to (38.917 nm) when forming additional nanostructure oxide film such as copper oxide.

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