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Fabrication of CdTe Nano Wires by Using Nano Porous Alumina Templates

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Abstract:

CdTe was chosen to be the dynamic material for the nano wires, and the interaction for the effective amalgamation of CdTe nano wires was created in this task. Two diverse combination approaches were examined in this task, electrochemical and electrophoretic testimony. While electrochemical blend was effectively utilized for the combination of nano wires inside the pores of the alumina templates, the method was resolved to be non-ideal because of the need of raised temperature that is negative to the underlying respectability of the nano porous alumina templates. To kill this issue, electrophoretic statement was chosen as the more fitting strategy, which includes the guided testimony of semiconductor nano particles within the sight of ultrasonic energy to shape the glasslike nano wires. Broad exploratory examination was completed to improve the cycle boundaries for arrangement of translucent nano wires. It was seen that the natural shower temperature assumes a basic part in deciding the primary uprightness of the nano wires and thus their lengths. Examination was done for the development of hazy ohmic contacts on the nano wires to work with photocurrent spectroscopy estimations just as for sun powered cell execution. Arrangement of such ohmic contacts was discovered to be testing and an interaction including mechanical and electrochemical cleaning was created to work with such contacts.

The utilization of nano porous alumina layouts for the surface finishing of mono-and multi-glasslike sun based cells was widely examined by electrochemical scratching of the silicon through the pores of the nano porous formats. The cycles for layout development just as drawing were advanced and the alumina/silicon interface was examined utilizing capacitance-voltage portrayal. The cycle created was discovered to be suitable for improving sun powered cell execution.

Keywords — **Nano Wires, Templates, Anodization.**

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I. Introduction

The construction comprises of semiconductor nano wires implanted in an alumina grid developed on a substrate containing the base electrical contact for the sun based cells the nano wires are reached at the top to shape the other electrical contact. The substrate is glass and the top contact is shaped with a straightforward conductor to permit full assimilation of the sun oriented radiation. What's more, the base contact is additionally liked to be shaped utilizing a straightforward conductor in order to permit future execution of multi junction sun based cells. The photons from the sunlight based radiation are consumed by the nano wires at moderately high proficiency because of the expanded thickness of conditions of the lower dimensional constructions. The inherent electric field isolates the electron-opening p[airs made because of photon retention which are gathered by the base and top electrical contacts. Because of the nano scale measurements of the dynamic material, it is normal that the implicit electric field delivered inside the nanostructures because of Fermi level sticking at the surface will be adequate to isolate the electron-opening sets created by the optical retention measure, hence dispensing with the requirement for P-N intersection development. Notwithstanding, assuming the inherent electric field ends up being deficient, PN intersections can be made by adding the fitting dopant materials during blend.

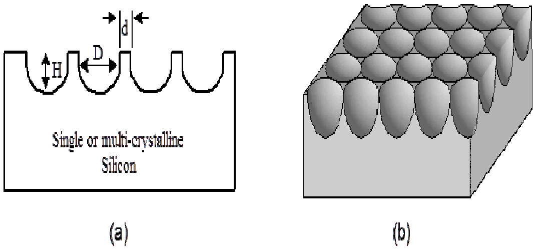
Another segment of this task is to utilize the slim film nano porous alumina formats to build up the innovation for the making of ideal surface finishing for the expanded effectiveness of mono and multi crystalline sun oriented cells. Surface finishing is regularly utilized in glasslike silicon photovoltaic cells to improve light assimilation and in this manner complete cell productivity. In this methodology, different reflections off of the finished silicon surfaces increment the likelihood of photon assimilation in the dynamic silicon material.

At the point when joined with reasonable enemy of reflection covering, this methodology has been shown to essentially upgrade the proficiency of translucent silicon photovoltaic cells. Procedures for surface finishing for both mono-and multi-translucent silicon have been a functioning region of exploration. For the instance of mono-glasslike silicon, the utilization of an anisotropic engraving that is particular to precious stone direction is regularly utilized. This methodology has advanced from the utilization of scratched square-based pyramid structures in the early COMSAT cells, to the upset pyramid structure utilized in the high proficiency PERL cells. What's more, lithographic cycles have been produced for surface finishing in high productivity mono-translucent PV cells. For the instance of multi-glasslike silicon gadgets, anisotropic engraving methods are not fitting because of the absence of very much characterized precious stone planes. The utilization of irregular finishing has been created for multi-glasslike silicon; anyway an enormous rate (28 %) of the episode light is reflected from these haphazardly finished surfaces.

Since the utilization of multi-translucent silicon PV gadgets seems, by all accounts, to be expanding, it is proper to examine elective finishing approaches that are appropriate for these gadgets. A few unique methodologies have been recently examined to give surface finishing to multi-glasslike silicon, including mechanical cutting, deformity drawing with acidic arrangements, responsive particle scratching, and lithographic surface designing. Nonetheless, every one of these procedures presents a few issues for business producing. While extensive work has been done on mechanical cutting, ease metallization on the profoundly notched surfaces is troublesome. Imperfection drawing requires the utilization of a lot of exclusive acidic arrangements. RIE is a generally sluggish vacuum measure that can likewise instigate undesirable harm to the silicon surface. At last, the utilization of lithographic cycles for finishing isn't financially savvy because of hardware cost and low throughput. Thus, it is critical to build up an ease, manifacturable surface finishing procedure that can give authority over pore shape and measurement, and is material for both mono-and multi-glasslike silicon.

One of the destinations of this task is to build up an electrochemical method for surface finishing that is pertinent for both mono-and multi-glasslike silicon PV cells. This methodology can non-lithographically duplicate the "honeycomb" structures anyway with altogether diminished level surface territory and consequently improved gadget execution. With this methodology, the pore thickness, measurement, and division can be autonomously controlled to deliver ideal light catching for a given cell plan. What's more, this methodology depends on grounded modern cycles and is appropriate for high-throughput fabricating. At last, the scratched constructions can be utilized as a guttering site to diminish the gem deformity thickness in the dynamic areas of the gadget.

The surface finishing method created in this undertaking depends on guided electrochemical scratching of silicon through the pores of an alumina layout shaped by the anodization of a flimsy film of aluminium saved on the substrate. Two perspectives on the proposed silicon surface design are appeared in Figure 1.



1Figure : (a) Cross-sectional and (b) Perspective view of the silicon surface texturing technology to be developed in this project. The height (H), diameter (D), and spacing (d) can be independently controlled with the proposed technique

II. Experimental method for CdTe nano wires

The dynamic nano wires in the sun based cells are executed by guided union utilizing the nano porous alumina formats. Two distinctive union strategies were researched in this task, explicitly electrochemical blend procedure and electrophoresis amalgamation strategy as depicted beneath.

In electrochemical amalgamation strategy, the semiconductor nano particles are combined inside the pores of the nano porous alumina formats utilizing an electric flow. Electrochemical amalgamation is an economical method for semiconductor blend and an appropriate one for sun based cells. In any case, electrochemical cycles should be enhanced to deliver greatest semiconductors. The nature of semiconductor material relies upon electrochemical boundaries like electrical flow, electrolyte creation and electrolyte temperature. A broad writing search was done to decide the most proper amalgamation procedure for sunlight based cell applications. A significant prerequisite for sun powered cells is improved translucent nature of the material. For the electro deposition of CdTe inside the pores of the anodized alumina formats, the accompanying electrochemical arrangements were utilized: $3CdSO_4.8H_2O$ (25.6 g L-1), TeO_2 (1.6 g L-1), and H_2SO_4 (98 g L-1). A 9-V battery was utilized as the force source, a platinum network was utilized as the anode, and the layout as the cathode. The response follows the energy as underneath:

$HTeO_2^+ \ 3H^+ + 4e^- \rightarrow Te + 2H_2O$

$Cd^2 + Te + 2e^- \rightarrow CdTe$

$Cd^{2+} + 2e \rightarrow Cd.$

Utilizing the above cycle, CdTe was electrochemically kept inside the pores of the alumina format. An orderly report was first completed to decide the ideal cycle boundaries for the affidavit of CdTe inside the pores. Various examples were readied utilizing the above cycle and the examples were described for primary attributes and material structure. The CdTe nano wires were portrayed utilizing EDS to decide the arrangement of the CdTe materials and the proportion was discovered to be 50:50 affirming the presence of CdTe. Figure 2 shows the cross-sectional examining electron magnifying instrument picture of a commonplace design showing the development of CdTe inside the pores of a nano porous alumina format.

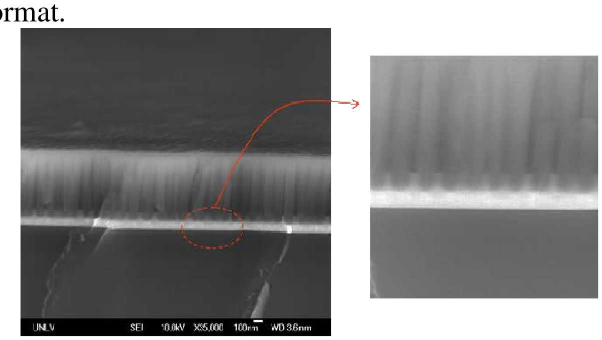


Figure 2. Cross-sectional scanning electron micrograph of CdTe formed inside the pores of a nano porous alumina template

III.ELECTROPHORETIC DEPOSITION PROCESS

One of the issues experienced with electrochemical amalgamation is that the development rate was extremely low at room temperature. Another worry was the nature of the precious stones shaped at lower temperatures. The development rate and the translucent nature of the nano wires can be expanded via completing combination at raised temperatures, notwithstanding, such a climate was discovered to be adverse to the trustworthiness of the nano porous alumina formats. To address these issues, in this undertaking another procedure, to be specific electrophoretic strategy, was explored and produced for the blend of CdTe nano wires. This new method includes the blend of nano wires through electrophoretic affidavit of pre-incorporated nano particles within the sight of ultrasonic energy; the ultrasonic energy melds the nano particles into a glasslike material inside the nano porous layout. This method is promising for the production of high glasslike quality nano wires with extremely high angle proportion. High glasslike nature of the nano wire is significant for proficient assortment of the photograph produced transporters. Then again, expanded nano wire length is needed to build the photocurrent. In the conventional electrochemical union of nano wires, it has been tracked down that the deformity thickness increments with expanding thickness of the nano wires.

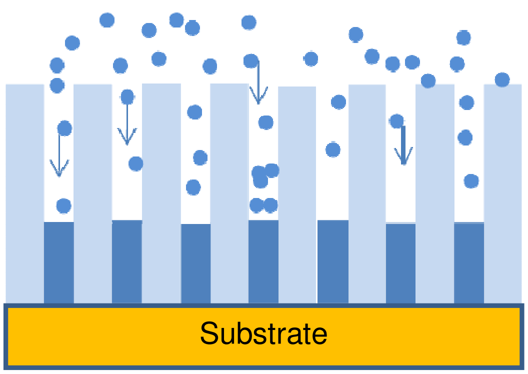


Figure3. Schematic representation of the electrophoretic deposition process and the ultrasonic equipment used for the deposition

IV. RESULTS & ANALYSIS

The electro phoretic amalgamation measure is schematically appeared in Figure 4. Pre-incorporated nano particles, commonly glasslike in nature, are guided inside the pores of the nano porous format through the use of an electric field. The guided nano particles are intertwined by the ultrasonic energy which is applied during the affidavit cycle. As referenced before, one of the benefits of this procedure is that the nano porous alumina film isn't presented to the electrochemical blend measure which can regularly include raised temperatures. To give the coordinated electric field, the unique example holder created for the anodization of aluminium films stored on glass substrates was utilized. Towards the advancement of the manufacture cycle, gold nano particles were at first utilized as the nano particle material. Gold nano particles combined by the electrophoretic procedure inside the nano porous alumina layouts within the sight of ultrasonic energy were researched for various ultrasonic energies and term. While assortment of gold nano particles inside the pores could at first be noticed, the total combination of the nano particles required broad cycle advancement and calibrating. The ultrasonic energy was shifted over a wide reach. It was seen that the examples with high ultrasonic energy showed a few harms to the format structure and keeping in mind that a portion of the gold nano particles show agglomeration, a significant number of them were dispersed and the control was lost. This was not unforeseen. In the lower energy range, the examples showed agglomeration, however not complete combination. It was important to decide the window of ultrasonic energy for which complete combination of the nano particles might be gotten without harming the design of the nano template. When the interaction was created, the blend of CdTe nano wires utilizing the electro phoretic method was examined. The window of ultrasonic energy for this material was discovered to be unique in relation to that of gold nano particles, true to form. Broad examination was done to upgrade the cycle boundaries, be that as it may, total combination of the nano particles and breakdown of the nano porous structure was normal.

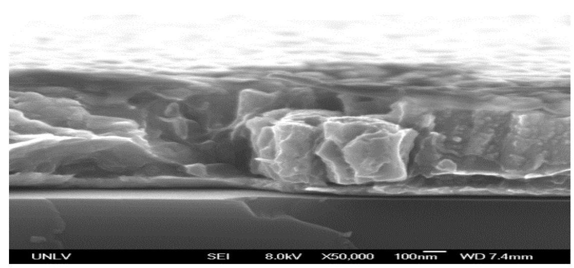


Figure 4 shows the picture of such a construction with breaking down of the nano porous format and combination with the nano particles.

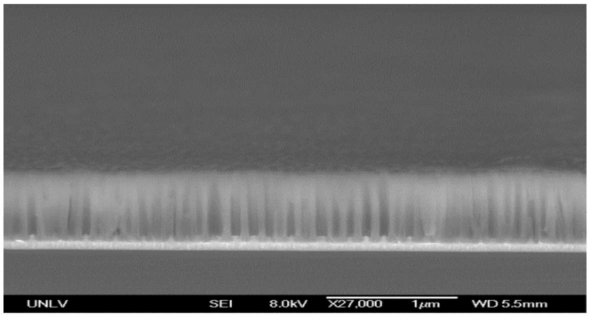


Figure 5. Cross-sectional structure showing formation of CdTe nano wires.

V. CONCULSIONS

One of the issues experienced with electro phonetic blend was the more modest length of the nano wires. For longer testimony time required for longer nano wires, it was seen that the nano porous format would deteriorate and intertwine with the nano particles as depicted before. The examples that were made utilizing expanded ultrasonic energy to decrease longer testimony times showed brokenness in the wires.

In light of our investigation, it was resolved that a lower temperature shower could alleviate a portion of the adverse consequences of the greater ultrasonic energy and give predominant quality movies. Further examinations were done by manufacturing extra examples utilizing comparative ultrasonic energy, notwithstanding, in a lower temperature climate and great outcomes were gotten as demonstrated in Figure 6.

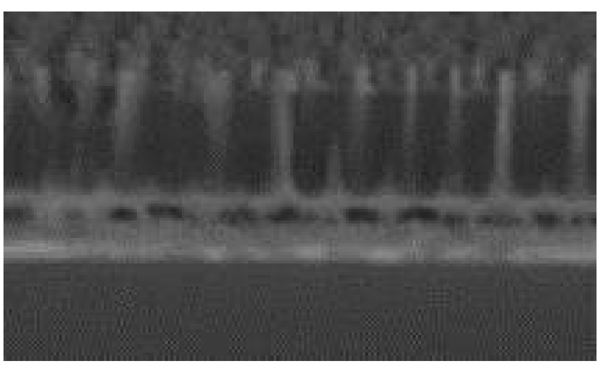


Figure 6. CdTe nano wires synthesized by guided synthesis through alumina template

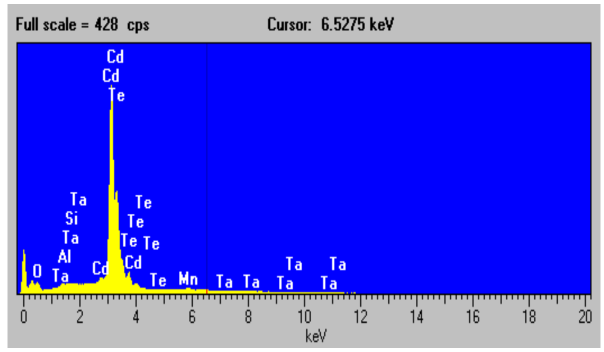


Figure 7 EDS spectra confirming correct composition of deposited CdTe.

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References:

[1] Asoh H., K. Nishio, M. Nakao, A. Yokoo, T. Tamamura & H. Masuda, 2001. Fabrication of ideally ordered anodic porous alumina with 63 nm hole periodicity using sulfuric acid. J. Vac. Sci. Technol. B19, 569.

[2] O'Sullivan J.P. and Wood G.C., The Morphology and Mechanism of Formation of Porous Anodic Films on Aluminum, Proc. Roy. Soc. Lond, 1970; A 317: 511-543.

[3] Parkhutik V.P. and Shershulsky V.I., Theoretical modelling of porous oxide growth on aluminium, J. Phys. D: Appl. Phys., 1992; 25: 1258-1263.

[4] Masuda H., Ohya M., Nishio K., Asoh H., Nakao M., Nohtomi M., Yokoo A. and Tamamura T., Photonic Band Gap in Anodic Porous Alumina with Extremely

High Aspect Ratio Formed in Phosphoric Acid Solution, Jpn. J. Appl. Phys., 2000; 39: L1039-L1041

[5] Wang Z.L., Novel nanostructures of ZnO for nanoscale photonics, optoelectronics, piezoelectricity, and sensing, Appl. Phys. A : Materials Science & Processing, 2007; 88(1): 7-15.

[6] Basu S., S. Chatterjee, M. Saha, S. Bandyo padhyay, K.K. Mistry & K. Sengupta, 2001. Study of electrical characteristics of porous alumina sensors for detection of low moisture in gases. Sensors and Actuators, B-Chemical 79, 182.

[7] Chu S.Z., K. Wada, S. Inoue & S. Todoroki, 2002. Formation and microstructures of anodic alumina films from aluminum sputtered on glass substrate. J. Electro chem. Soc. 149, B321.

[8] Cibert J., Petroff P.N., Dolan G.J., Pearton S.J., Gossard A.C., English J.H., Appl. Phys. Lett., 49, 1275, 1986.

[9] Kirstaedter N., Ledentsov N. N., Grundmann M., Bimberg D., Ustinov V.M., Ruvimov S. S., Maximov M. V., Kopev P. S., Alferov Zh. I., Richter U., Electronics Letters, 30, 1416, 1994.

[10] Fafard S., Hinzer K., Raymond S., Dion M., McCaffrey J., Charboneau S., Science, 274, 1350, 1997.

[11] S.P. McGinnis and B. Das; IEEE Cornell Conference on Advanced Concepts in High Speed Semiconductors and Circuits, August 1995.

[12] S. McGinnis, P. Sines and B. Das, “Electrochemical fabrication of semiconductor quantum wires for photovoltaic applications”, 3 rd International Conference on Low Dimensional Structures and Devices, Antalya, Turkey, Sept. 1999.

[13] S.P. McGinnis, P. Sines, C. Garman, D. Grey, W. Zhang, and B. Das, “Template Based High Efficiency Nanostructure Photovoltaic Cells”, 28th IEEE Photovoltaic Specialist Conference, Anchorage, AK, Sept. 2000.

[14] B. DAS, S.P. MCGINNIS AND P. SINES, “HIGH EFFICIENCY SOLAR CELLS BASED ON SEMICONDUCTOR NANOSTRUCTURES”, SOLAR ENERGY MATERIALS & SOLAR CELLS, 63, PP. 117-123, 2000.