Elaboration and Characterization of Silicon Nanowires for Solar cells

LCPM

M. Toure[a], D. Kobor[a], L. Ottaviani[b], M. Pasquinelli[b], J. Lerouzo[b] et S. Bastide[c]

[a]LCPM, UFR Sciences et Technologies, Université Assane Seck de Ziguinchor
[b]IM2NP (UMR CNRS 7334) – Université Aix-Marseille
[c]Institut de Chimie et des Matériaux de Paris – Est (ICMPE)

1 Introduction

With nanotechnology, how to improve the performance and reduce the cost solar cell production?

What criteria / What possible creative solutions?

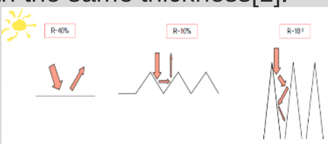
One of the solutions: Silicon Nanowires

2 Why silicon nanowires?

Crystalline silicon nanowires follows the same strategy as thin layers: reduce the amount of absorbing material while maintaining high yields.

- ✓ Thanks to their sub-micron size, the optical absorption of nanowires assembly is greater than that of a thin layer with the same thickness[1].

Figure 1: Reduction of reflection depending on the structure of the absorbing surface



- ✓ Particular geometry: radial junction (junction around the nanowire) and axial (along the nanowire) [1]

Figure2:Representation of the axial and radial junction in a nanowire

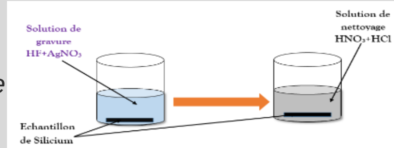
- ✓ Using silicon electronic poorer quality while maintaining a good collection of the carriers [1].
- ✓ Possibility of using silicon nanowires produced by a catalyzed growth technique, the electronic quality is reduced by metal contamination [1]

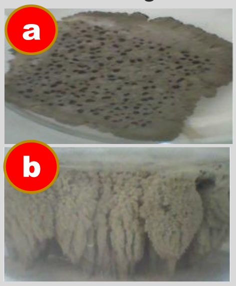
3 Elaboration of silicon nanowires

General routes Synthesis of silicon nanowires: Bottom-up (CVD...), top-down (lithography...) [2]

Metal Assisted Chemical Etching: Process (figure3) and Mechanism (figure4)

Figure3: Process for stripping and cleaning of the silicon sample





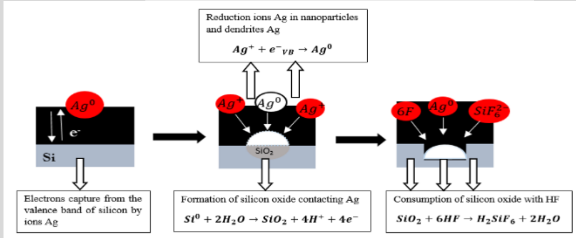


Figure 4:Reaction mechanism,(a) microspores (b)Foam Silver

4 SEM characterization

Keeping the concentration of the solution fixed etching, nanowires obtained (Figure 5) have a length of between 9.549 and 25.13 microns depending on the time of attack. This length is uniform over the same substrate regardless of the sample size. These results are in agreement with those of PIRET [3]. Figure 5 also allows us to see the evolution of the density of nanowires as a function of time. The organization of nanowires is different for each attack time. More time is longer, low is the nanowires density

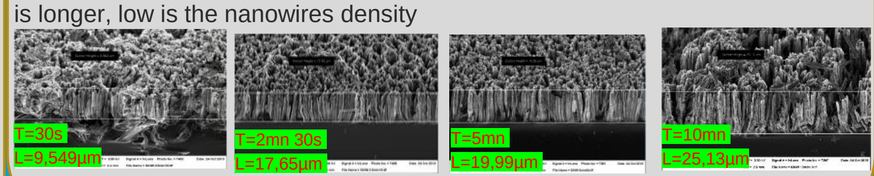


Figure 5 SEM images of silicon nanowires as a function of etching time

5 Optical Characterization

The reflection values is relatively low (approximately 10%) for samples of nanowires for the range of wavelengths useful for photovoltaic conversion waves indicating a good absorption of light in the device. On the other hand, the reflection decreases as the length of the nanowires obtained. The reflection increases as soon as the nanowires length

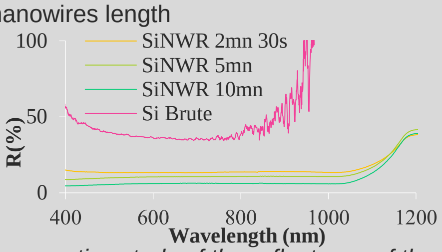
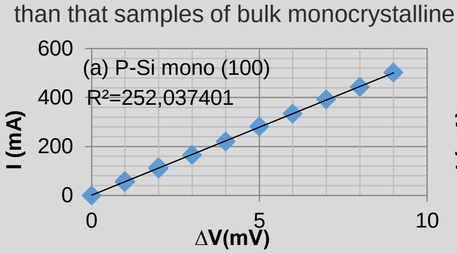


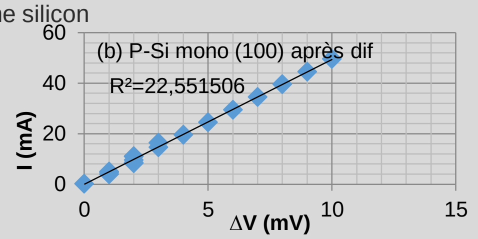
Figure 6: Comparative study of the reflectance of the bulk silicon and the nanowires as a function of time

6 Electrical Characterization: Method 4 pointes [4]

The resistivity is given by: $\rho = R \times d$ with $R = \left(\frac{\pi}{\ln 2}\right) \times \left(\frac{\Delta V}{I}\right)$

It is noted that the resistivity (figure 8) of the samples decreases with a multiplicative factor **1/10**. It goes from **R^2=252,0374** for the silicon type p single crystal **R^2= 2,103732** substrate for the silicon nanowire. This allows us to conclude the samples silicon nanowires have a much greater electrical conductivity than that samples of bulk monocrystalline silicon





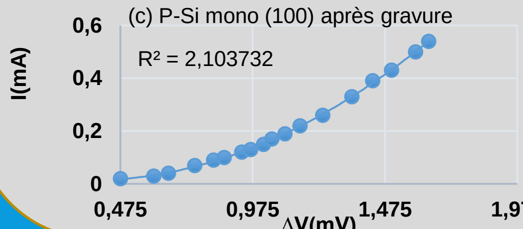


Figure 8: Change in I versus ΔV

7 Conclusion and Perspective

- ✓ Nanowires obtained chemically with catalyst Silver
- ✓ Nanowires optical and electrical characteristics better than those of monocrystalline silicon. Therefore solar cells based on nanowires should have a better performance than those sold.
- ✓ Use of other catalysts (Aluminum, Copper, Iron, Zinc)
- ✓ Realization and characterization of solar cells based on these nanowires
- ✓ A comparative study with conventional solar cells

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8 Bibliographies

[1] Chamilo2.grenet.fr/Cours23emegeneration
[2] Florie MARTINEAU « Elaboration de nanofils et de nanotubes par électrodéposition en liquide liquide ionique et propriétés d'émission associées » Soutenu le 25 août 2011
[3] Gaëlle OFFRANC PIRET « Nanofils de silicium pour une analyse sensible de biomolécules par spectrométrie de masse et pour l'adressage fluidique de cellules, en vue des applications laboratoires sur puce et biopuces. »
[4] Méthodes_de_Caractérisations_V2M12