In situ inclusion of Au nanoparticles in porous silicon structure

Applied Physics A

January 2017, 123:83 | Cite as

- F. Severiano (1) Email author (balarama_1@yahoo.com.mx)
- V. L. Gayou (1)
- G. García (2)
- R. Delgado Macuil (1)
- H. Martínez Gutiérrez (3)
- G. Nieto (4)
- T. Diaz (2)

1. Instituto Politécnico Nacional, Centro de Investigación en Biotecnología Aplicada Unidad Tlaxcala, , Tlaxcala, Mexico
2. CIDS-ICUAP, Benemérita Universidad Autónoma de Puebla, , Puebla, Mexico
3. Instituto Politécnico Nacional, CNMN, Calle Luis Enrique Erro s/n, , México, Mexico
4. Facultad de Ciencias Químicas, Benemérita Universidad Autónoma de Puebla, , Puebla, Mexico

Article
First Online: 26 December 2016
Received: 28 July 2016
Accepted: 19 December 2016

Abstract

The aim of this work was to study the structural modification in the porous silicon layer (PSL), when they are obtained from electrodeposition using a metal salt of Au ($HAuCl_4$) in the electrolyte. The deposition of Au nanoparticles and the formation of the PSL were performed simultaneously. The structural and optical properties of the gold/porous-Si were analyzed by scanning electron microscopy (SEM), X-ray energy dispersive spectroscopy (EDS), photoluminescence (PL) and Raman scattering. Through the methodology implemented, it was obtained gold/porous-Si nanocomposites. The size of the gold nanoparticles was above 15 nm, and the pore size was 18 nm. The PL intensity showed an increase with the incorporation of gold nanoparticles due to the enhancement of a surface plasmon effect. The size of Si nanocrystals in the PSL structure was estimated through PL and Raman measures and it was ~3 nm.

Keywords

Energy Dispersive Spectroscopy Metal Salt Porous Silicon Electrochemical Etching Silicon Nanocrystals
These keywords were added by machine and not by the authors. This process is experimental and the keywords may be updated as the learning algorithm improves.

Notes

Acknowledgements

F. Severiano thanks CONACyT for its support through 211350 studentship.

References

1. L.T. Canham, T.I. Cox, A. Loni, A.J. Simons, Appl. Surf. Sci. **102**, 436–441 (1996)
ADS (http://adsabs.harvard.edu/cgi-bin/nph-data_query?link_type=ABSTRACT&bibcode=1996ApSS..102..436C)
CrossRef (https://doi.org/10.1016/0169-4332(96)00094-3)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=LT.%20Canham&author=TI.%20Cox&author=A.%20Loni&author=AJ.%20Simons&journal=Appl.%20Surf.%20Sci.&volume=102&pages=436-441&publication_year=1996)
2. J.L. Coffer, M.A. Whitehead, D.K. Nagesha, P. Mukherjee, G. Akkaraju, M. Totolici, R.S. Saffie, L.T. Canham, Phys. Status Solidif. A-Appl. Mater. **202**, 1451–1455 (2005)
ADS (http://adsabs.harvard.edu/cgi-bin/nph-data_query?link_type=ABSTRACT&bibcode=2005PSSAR.202.1451C)
CrossRef (https://doi.org/10.1002/pssa.200461134)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=JL.%20Coffer&author=MA.%20Whitehead&author=DK.%20Nagesha&author=P.%20Mukherjee&author=

G.%20Akkaraju&author=M.%20Totolici&author=RS.%20Saffie&author=LT.%20Canham&journal=Phys.%20Status%20Solidif.%20A-Appl.%20Mater.&volume=202&pages=1451-1455&publication_year=2005)

3. S. Chattopadhyay, X. Li, P.W. Bohn, J. Appl. Phys. **91**, 6134–6140 (2002)
ADS (http://adsabs.harvard.edu/cgi-bin/nph-data_query?link_type=ABSTRACT&bibcode=2002JAP....91.6134C)
CrossRef (https://doi.org/10.1063/1.1465123)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=S.%20Chattopadhyay&author=X.%20Li&author=PW.%20Bohn&journal=J.%20Appl.%20Phys.&volume=91&pages=6134-6140&publication_year=2002)

4. K. Peng, J. Hu, Y. Yan, Y. Wu, H. Fang, Y. Xu, S.T. Lee, J. Zhu, Adv. Funct. Mater. **16**, 387–394 (2006)
CrossRef (https://doi.org/10.1002/adfm.200500392)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=K.%20Peng&author=J.%20Hu&author=Y.%20Yan&author=Y.%20Wu&author=H.%20Fang&author=Y.%20Xu&author=ST.%20Lee&author=J.%20Zhu&journal=Adv.%20Funct.%20Mater.&volume=16&pages=387-394&publication_year=2006)

5. A.G. Cullis, L.T. Canham, P.D.J. Calcott, J. Appl. Phys. **82**, 909–965 (1997)
ADS (http://adsabs.harvard.edu/cgi-bin/nph-data_query?link_type=ABSTRACT&bibcode=1997JAP....82..909C)
CrossRef (https://doi.org/10.1063/1.366536)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=AG.%20Cullis&author=LT.%20Canham&author=PDJ.%20Calcott&journal=J.%20Appl.%20Phys.&volume=82&pages=909-965&publication_year=1997)

6. G.G. Qin, Phys. Status Solidif. A **182**, 335–339 (2000)
ADS (http://adsabs.harvard.edu/cgi-bin/nph-data_query?link_type=ABSTRACT&bibcode=2000PSSAR.182..335Q)
CrossRef (https://doi.org/10.1002/1521-396X(200011)182%3A1<335%3A%3AAID-PSSA335>3.0.CO%3B2-W)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=GG.%20Qin&journal=Phys.%20Status%20Solidif.%20A&volume=182&pages=335-339&publication_year=2000)

7. H. Koyama, Y. Matsushita, N. Koshida, J. Appl. Phys. **83**, 1776–1778 (1998)
ADS (http://adsabs.harvard.edu/cgi-bin/nph-data_query?link_type=ABSTRACT&bibcode=1998JAP....83.1776K)
CrossRef (https://doi.org/10.1063/1.366899)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=H.%20Koyama&author=Y.%20Matsushita&author=N.%20Koshida&journal=J.%20Appl.%20Phys.&volume=83&pages=1776-1778&publication_year=1998)

8. A. Brewer, K. von Haeften, Appl. Phys. Lett. **94**, 261102-1–261102-3 (2009)
ADS (http://adsabs.harvard.edu/cgi-bin/nph-data_query?link_type=ABSTRACT&bibcode=2009ApPhL..94z1102B)
CrossRef (https://doi.org/10.1063/1.3167355)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=A.%20Brewer&author=K.%20Haeften&journal=Appl.%20Phys.%20Lett.&volume=94&pages=261102-1-261102-3&publication_year=2009)

9. M.B. de la Mora, J. Bornacelli, R. Nava, R. Zanella, J.A. Reyes-Esqueda, J. Lumin. **146**, 247–255 (2014)
CrossRef (https://doi.org/10.1016/j.jlumin.2013.09.053)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=MB.%20Mora&author=J.%20Bornacelli&author=R.%20Nava&author=R.%20Zanella&author=JA.%20Reyes-Esqueda&journal=J.%20Lumin.&volume=146&pages=247-255&publication_year=2014)

10. G.G. Qin, Y.J. Li, Phys. Rev. B **68**, 1–7 (2003)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=GG.%20Qin&author=YJ.%20Li&journal=Phys.%20Rev.%20B&volume=68&pages=1-7&publication_year=2003)

11. C. Hong, H. Kim, S. Park, C. Lee, J. Eur. Ceram. Soc. **30**, 459–463 (2010)
CrossRef (https://doi.org/10.1016/j.jeurceramsoc.2009.08.010)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=C.%20Hong&author=H.%20Kim&author=S.%20Park&author=C.%20Lee&journal=J.%20Eur.%20Ceram.%20Soc.&volume=30&pages=459-463&publication_year=2010)

12. M. Atyaoui, W. Dimassi, M. Khalifa, R. Chtourou, H. Ezzaouia, J. Lumin. **132**, 2572–2576 (2012)
CrossRef (https://doi.org/10.1016/j.jlumin.2012.04.054)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=M.%20Atyaoui&author=W.%20Dimassi&author=M.%20Khalifa&author=R.%20Chtourou&author=H.%20Ezzaouia&journal=J.%20Lumin.&volume=132&pages=2572-2576&publication_year=2012)

13. C. Hong, H. Kim, H.W. Kim, C. Lee, Met. Mater. Int. **16**, 311–315 (2010)
CrossRef (https://doi.org/10.1007/s12540-010-0423-y)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=C.%20Hong&author=H.%20Kim&author=HW.%20Kim&author=C.%20Lee&journal=Met.%20Mater.%20Int.&volume=16&pages=311-315&publication_year=2010)

14. K. Peng, H. Fang, J. Hu, Y. Wu, J. Zhu, Y. Yan, S.T. Lee, Chem. Eur. J. **12**, 7942–7947 (2006)
CrossRef (https://doi.org/10.1002/chem.200600032)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=K.%20Peng&author=H.%20Fang&author=J.%20Hu&author=Y.%20Wu&author=J.%20Zhu&author=Y.%20Yan&author=ST.%20Lee&journal=Chem.%20Eur.%20J.&volume=12&pages=7942-7947&publication_year=2006)

15. F. Severiano, G. García, L. Castañeda, M. Salazar Villanueva, J. Flores Méndez, J. Nanomater. Article ID 942786 (2015)
Google Scholar (https://scholar.google.com/scholar?q=F.%20Severiano%2C%20G.%20Garc%C3%ADa%2C%20L.%20Casta%C3%B1eda%2C%20M.%20Salazar%20Villanueva%2C%20J.%20Flores%20M%C3%A9ndez%2C%20J.%20Nanomater.%20Article%20ID%20942786%20%282015%29)

16. E. Edelberg, S. Bergh, R. Naone, M. Hall, E.S. Aydil, Luminescence from plasma deposited silicon films. J. Appl. Phys. **81**(5), 2410–2417 (1997)
ADS (http://adsabs.harvard.edu/cgi-bin/nph-data_query?link_type=ABSTRACT&bibcode=1997JAP....81.2410E)
CrossRef (https://doi.org/10.1063/1.364247)
Google Scholar (http://scholar.google.com/scholar_lookup?title=Luminescence%20from%20plasma%20deposited%20silicon%20films&author=E.%20Edelberg&author=S.%20Bergh&author=R.%20Naone&author=M.%20Hall&author=ES.%20Aydil&journal=J.%20Appl.%20Phys.&volume=81&issue=5&pages=2410-2417&publication_year=1997)

17. G.-R. Lin, C.-J. Lin, C.-K. Lin, L.-J. Chou, and Y.-L. Chueh, Oxygen defect and Si nanocrystal dependent white-light and near-infrared electroluminescence of Si-implanted and plasma enhanced chemical-vapor deposition-grown Si-rich SiO_2. J. Appl. Phys. **97**(9), Article ID094306 (2005)
Google Scholar (https://scholar.google.com/scholar?q=G.-R.%20Lin%2C%20C.-J.%20Lin%2C%20C.-K.%20Lin%2C%20L.-J.%20Chou%2C%20and%20Y.-L.%20Chueh%2C%20Oxygen%20defect%20and%20Si%20nanocrystal%20dependent%20white-light%20and%20near-infrared%20electroluminescence%20of%20Si-implanted%20and%20plasma%20enhanced%20chemical-vapor%20deposition-grown%20Si-rich%20SiO2.%20J.%20Appl.%20Phys.%2097%289%29%2C%20Article%20ID094306%20%282005%29)

18. Z. Iqbal, S. Veprek, J. Phys. C: Solid State Phys. **15**, 377–392 (1982)
ADS (http://adsabs.harvard.edu/cgi-bin/nph-data_query?link_type=ABSTRACT&bibcode=1982JPhC...15..377I)
CrossRef (https://doi.org/10.1088/0022-3719/15/2/019)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=Z.%20Iqbal&author=S.%20Veprek&journal=J.%20Phys.%20C%3A%20Solid%20State%20Phys.&volume=15&pages=377-392&publication_year=1982)

19. G. Kenellis, J.F. Morhange, M. Balkanski, Phys. Rev. B **21**, 1543 (1980)
ADS (http://adsabs.harvard.edu/cgi-bin/nph-data_query?link_type=ABSTRACT&bibcode=1980PhRvB..21.1543K)
CrossRef (https://doi.org/10.1103/PhysRevB.21.1543)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=G.%20Kenellis&author=JF.%20Morhange&author=M.%20Balkanski&journal=Phys.%20Rev.%20B&volume=21&pages=1543&publication_year=1980)

20. M. Cardona, in *Light Scattering in Solid II*, ed. by M. Cardona, G. Guntherodt (Springer, New York, 1982), p. 19
CrossRef (https://doi.org/10.1007/3-540-11380-0_14)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=M.%20Cardona&pages=19&publication_year=1982)

21. R. Tsu, H. Shen, M. Dutta, Appl. Phys. Lett. **60**, 112–114 (1992)
ADS (http://adsabs.harvard.edu/cgi-bin/nph-data_query?link_type=ABSTRACT&bibcode=1992ApPhL..60..112T)
CrossRef (https://doi.org/10.1063/1.107364)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=R.%20Tsu&author=H.%20Shen&author=M.%20Dutta&journal=Appl.%20Phys.%20Lett.&volume=60&pages=112-114&publication_year=1992)

Copyright information

About this article

Cite this article as:
Severiano, F., Gayou, V.L., García, G. et al. Appl. Phys. A (2017) 123: 83. https://doi.org/10.1007/s00339-016-0718-z

- DOI (Digital Object Identifier) https://doi.org/10.1007/s00339-016-0718-z
- Publisher Name Springer Berlin Heidelberg
- Print ISSN 0947-8396
- Online ISSN 1432-0630

- About this journal
- Reprints and Permissions

Personalised recommendations