Optical and Electrical Properties of Silicon Based MILC PN Junction Diode

李坤樹、黃俊達

E-mail: 9606953@mail.dyu.edu.tw

ABSTRACT

Recently, polycrystalline silicon (Poly-Si) has received increasing attention because of its wide range application, such as Thin Film Transistor (TFT) for liquid crystal display, solar cell and image sensors. The growth methods of Poly-Si include (1) Solid Phase Crystallization (SPC) (2) Excimer Laser Annealing (ELA) (3) Metal-Induced Crystallization (MIC). However, SPC method have high growth temperature (above 700℃), resulting in fused quartz or silicon substrate is needed, which is high cost. The ELA method is expensive and cannot mass production due to laser annealing. In this experiment, we deposited the hydrogenated amorphous silicon (a-Si:H) films by Plasma-enhanced chemical vapor deposition (PECVD) system; then, the metal-induced lateral crystallization (MILC) of hydrogenated amorphous silicon (a-Si:H) thin films was processed having various thicknesses of nickel (Ni) films (10~25nm) at 550℃.The n-type Poly-Si film was grown on p-Si subatrate by using MILC method; then, a p/n junction solar cell was fabricated. It was found that the Poly-Si films prepared by MILC method have a nano- grain size of about 20~ 65 nm. The MILC method was treated by using RTA system at 550℃ for 6 hours. The optimal crystallization was achieved in the samples having 20 nm thick Ni films. The ratio of photo-to-dark-current ratio was 23, and the measured conversion efficiency of the solar cell was 6.1% by AM1.

Keywords : Poly-Si ; Metal-Induced Lateral Crystallization ; Rapid Thermal Annealing ; Amorphous Silicon ; Nano-Si gain size ; Photo-to-Dark-current ratio ; Conversion Efficiency

Table of Contents

REFERENCES

[1] Zhongyang Xu, Xuecheng Zou, Xuemei Zhou, Bofang Zhao, and Changan Wang, J. Appl. Phys. 75 (1994) 588.

[2] T. Aoyama, G Kawachi, N. Konishi,T. Suzuki, Y. Okajima, and K.Miyata, J.Electrochem.Soc.,vol136,No.4, pp.1169-1173,1989 [3] G. Radnoczi, A. Robertsson, H.T.G. Hentzell, S.F. Gong, and M.A. Gasan, J. Appl.Phys., 69(9), pp.6394-6399,1991.

[4] S. Y. Yoon, K. H. Kim and C. O. Kim, J. Appl. Phys., 82(11), pp.5865-5867,1997.

[5] M. S. Haque, H. A. Naseem and W. D. Brown, J. Appl. Phys., 79(10), pp.7529-7536, 1996.

[6] H. L. Gaigher, and N. G. Van Der erg, Thin Solid Films 68, pp.373, 1980.

[7] B. Y. Tsaur, and J. W. Mayer, Philosophical Magazine A, vol.43, pp.345, 1981.

[8] L. Hultman, A. Robersson, and H. T. G. Hentzell, J. Appl. Phys. 62(9), pp.3647, 1987.

[9] G. Radnoczi, A. Robersson, H. T. G. Hentzell, S. F. Gong, and M. A. Hasan, J. Appl. Phys.69(9), pp.6394-6399, 1991.
[10] M. S. Haque, H. A. Naseem and W. D. Brown, J. Appl. Phys., 75(8), pp.3928, 1994.
[11] M. S. Ashtikar, and G. L. Sharma, J. Appl. Phys.,78(2), pp.913, 1995.
[12] K. Nakamura, J. O. Olowolafa, S. S. Lau, M-A. Nicolet, and J. .Mayer, J. Appl. Phys., vol.47, pp.1278, 1976.
[13] S. W. Russell, Jian Li, and J. W. Mayer, J. Appl. Phys., 70(9), pp.5153, 1991.
[14] B. Bian, J. Yie, B. Li, and Z. Wu, J. Appl. Phys. 73(11), pp.7402, 1993.
[15] R. J. Nemanich, R. T. Fulks, B. L. Stafford, and H. A. Vander Plas, J. Vac. Sci. Technol. A3(3), PP.938, 1985.
[16] E. Nygren, A. P. Pogany, K. T. Short, and J. S. Williams, Appl. Phys, Lett. 55(6), pp.439, 1988.
[17] S. W. Lee, Y. C. Jeon, and S. K.Joo, APPL. Phys. Lett. 66(13), pp.1671, 1995.
[18] F. d ' Heurle, S. Petersson, and L. S tolt, and B. Strizker, J. Appl. Phys., vol. 53, pp.5678, 1982.
[19] Y. Kawazu, H. Kudo, S. Onari, and T. Arai, J. J. Appl. Phys., vol. 29, pp.729, 1990.
[20] T. J. Konno, and R. Sinclair, Materials Science and Engineering. A179/A180, PP.426, 1994.
[21] S. Y. Yoon, K. H. Kim, and C. O. Kim, J. Appl.Phys. 82(11), pp.5865, 1997.
[22] S. W. Lee, Y. C. Jeon and S. K. Joo, Appl.Phys.Lett. 66（13）, pp.1671-1673,1995.
[23] S.W. Lee and S. K. Joo, IEEE-EDL, vol.17, no.4, pp.160-162, 1996.
[24] S. W. Lee, T. H. Ihn and S. K. Joo, IEEE-EDL, vol.17, no.8, pp.407-409, 1996.
[25] Z. Jin, G. A. Bhat, M. Yeung, H. S. Kwok, and M. Wong, J. Appl. Phys.,vol. 84, pp194, 1998.
[26] Z. Jin, K. Moulding, H. S. Kwok, and M. Wong, IEEE Trans. Electron Devices, vol. 46, pp.78, 1999.
[27] H. C. Cheng, C. Y. Huang, F. S. Wang, K. H. Lin and F. G. Tarntair, J. J. App. Phys, Vol. 39, L19-L21, 2000.
[28] E. A. Guliants, W. A. Anderson, L. P. Guo, and V. V. Guliants, Thin Solid Films, vol. 385, pp.74, 2001.
[29] E. A. Guliants, C. Ji, Y. J. Song, and W. A. Anderson, Appl. Phys. Lett.,vol. 80, pp.1474, 2002.
[30] E. A. Guliants, and W. A. Anderson, J. Appl. Phys., vol. 87, pp.3535, 2000.
[31]C. Ji, and W. A. Anderson, IEEE, Photovoltaic Specialists Conference, Conference Record of the Thirty-first, pp.1460, 2005.