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论文

一种印刷型薄膜太阳能电池p-n结调制技术

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摘要:

能带值为0.5~0.85 eV材料的稀缺是多结太阳能电池面临的一个主要挑战,本文使用非真空的机械化学法合成了能带值为0.83 eV的Cu_2SnS_3化合物,使用印刷技术将其制备成吸收层薄膜,并采用superstrate太阳能电池结构(Mo/Cu_2SnS_3/In_2S_3/TiO_2/FTO glass)对其光伏特性进行了研究.实验表明所制备的太阳能电池短路电流密度、开路电压、填充因子和转换效率分别为12.38 mA/cm^2、320 mV、0.28和1.10%.此外,为更好地满足多结太阳能电池对电流匹配的需求,本文对所制备太阳能电池的Cu_2SnS_3/In_2S_3 p-n结进行了分析.通过在p-n结界面植入一层薄的疏松缓冲层,使调制后的太阳能电池短路电流密度从最初的12.38 mA/cm^{2}增加到了23.15 mA/cm^2,相应太阳能电池转换效率从1.1%增加到了1.92%.该p-n调制技术对印刷型薄膜太阳能电池具有重要借鉴意义.

关键词: Cu_2SnS_3薄膜太阳能电池 非真空印刷法 In_2S_3/Cu_2SnS_3 p-n结调制技术

A p-n Junction Modulation Technique for Printed Thin Film Solar Cell

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Abstract:

The scarcity of materials with band gap value of 0.5~0.85 eV is one of the major challenges for the multi-junction solar cells. In this study, the compounds Cu_2SnS_3 with band gap of 0.83 eV is synthesized by non-vacuum mechanochemical method, and is prepared into absorber layer by non-vacuum printing technique. The photovoltaic properties of the Cu_2SnS_3 are studied by employing a superstrate solar cell structure of Mo/Cu_2SnS_3/In_2S_3/TiO_2/FTO glass. Experiment result indicates that the short-circuit current density, open-circuit voltage, fill factor and conversion efficiency of the fabricated solar cell are 12.38 mA/cm^2, 320 mV, 0.28% and 1.10%, respectively. Furthermore, to better meet the requirements of multi-junction solar cell on the current matching, the Cu_2SnS_3/In_2S_3 p-n junction of the fabricated solar cell is analyzed. A p-n modulation technique with a thin porous buffer layer inserted into the p-n junction interface is proposed. The results indicate that the technique can promote the short-circuit current density of the solar cell from initial 12.38 mA/cm^2 to 23.15 mA/cm^2, and the corresponding solar cell conversion efficiency from 1.1% to 1.92%. This p-n modulation technique can be an important reference to the printed thin film solar cells.

Keywords: Cu_2SnS_3 thin film solar cell Non-vacuum printing technology In_2S_3/Cu_2SnS_3 p-n junction modulation technique

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[1] GUTER W, SCHONE J, PHILIPPS S P, et al. Current-matched triple-junction solar cell reaching 41.1% conversion efficiency under concentrated sunlight[J]. Applied Physics Letters, 2009, 94(22): 223504.

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[2] LI Hui, WANG Tao, LI Bao-xia, et al. LP-MOCVD Growth of GaInP$_2$/GaAs/Ge two-junction series-connected tandem solar cells[J]. Acta Photonica Sinica, 2002, 31(2): 209-212. 李辉,汪韬,李宝霞,等. GaInP$_2$/GaAs/Ge叠层太阳电池材料的低压MOCVD外延生长[J].光子学报,2002,31(2):209-212.
[3] KING R R, LAW D C, EDMONDSON K M, et al. 40% efficient metamorphic GaInP/GaInAs/Ge multijunction solar cells[J]. Applied Physics Letters, 2007, 90(18): 183516-1-3.
[4] XU Qin-feng, YE Qing, QU Rong-hui, et al. Influence of thermal effect on multi-junction GaInP/GaAs/Ge concentrating photovoltaic system[J]. Chinese Optics Letters, 2010, 8(4): 354-356.
[5] SHOCKLEY W, QUEISSER H J J. Detailed balance limit of efficiency of p-n junction solar cells[J]. Journal of Applied Physics, 1961, 32(3): 510-511.
[6] VOS A D. Detailed balance limit of the efficiency of tandem solar cells[J]. Journal of Physics D: Applied Physics, 1980, 13(5): 839-846.
[7] NISHIWAKI S, SIEBENTRITT S, WALK P, et al. A stacked chalcopyrite thin-film tandem solar cell with 1.2 V open-circuit voltage[J]. Progress in Photovoltaics: Research and Applications, 2003, 11(4): 243-248.
[8] LIU Bao-qi, ZHAO Xiao-peng. Properties of solar cells sensitized by mixed dye of plant[J]. Acta Photonica Sinica, 2006, 35(2): 184-187. 刘宝琦,赵晓鹏.混合植物染料敏化的太阳能电池性能[J]. 光子学报,2006,35(2):184-187.
[9] THAMPI K R, GRATZEL M, BREMAUD D, et al. Nanocrystalline dye-sensitized solar cell/copper indium gallium selenide thin-film tandem showing greater than 15% conversion efficiency[J]. Applied Physics Letters, 2006, 88(20): 203103.
[10] KIM J Y, LEE K, COATES N E, et al. Efficient tandem polymer solar cells fabricated by all-solution processing[J]. Science, 2007, 317(5835): 222-225.
[11] LIU Fan-fang, SUN Yun, WANG He, et al. Rapid Thermal Annealing on Cu(In,Ga)Se$_2$ films and solar cells with different content ratios[J]. Acta Photonica Sinica, 2009, 38(9): 2188-2191.
[12] FERNANDES P A, SALOME P M P, CUNHA A F Da. A study of ternary Cu_2SnS_3 and Cu_3SnS_4 thin films prepared by sulfurizing stacked metal precursors[J]. Journal of Physics D: Applied Physics, 2010, 43(21): 215403.
[13] LI B, XIE Y, HUANG J, et al. Synthesis, characterization, and properties of nanocrystalline Cu_2SnS_3 [J]. Journal of Solid State Chemistry, 2000, 153(1): 170-173.
[14] YOSHINO K, YOKOYAMA H, MAEDA K, et al. Crystal growth and photoluminescence of $CuIn_xGa_{1-x}Se_2$ alloys[J]. Journal of Crystal Growth, 2000, 211(1-4): 476-479.
[15] FERNANDES P A, SALOME P M P. A study of ternary Cu_2SnS_3 and Cu_3SnS_4 thin films prepared by sulfurizing stacked metal precursors[J]. Journal of Physics D: Applied Physics, 2010, 43(21): 215403.
[16] AVELLANEDA D, NAIR M T S, NAIR P K. Cu_2SnS_3 and Cu_4SnS_4 thin films via chemical deposition for photovoltaic application[J]. Journal of The Electrochemical Society, 2010, 157(6): D346-D352.
[17] BOUAZIZ M, AMLOUK M, BELGACEM S. Structural and optical properties of Cu_2SnS_3 sprayed thin films[J]. Thin Solid Films, 2009, 517(7): 2527-2530.
[18] CHEN Qing-miao, DOU Xiao-ming, LI Zhen-qing, et al. Printed ethyl cellulose/$CuInSe_2$ composite light absorber layer and its photovoltaic effect[J]. Journal of Physics D: Applied Physics, 2011, 44(45): 455401.
[19] MARIAN N, JOOP S, ALBERT G. Nanocomposite three-Dimensional solar cells obtained by chemical spray deposition[J]. Nano Letters, 2005, 5(9): 1716-1719.
[20] JOHN T T, BINI S, KASHIWABA Y, et al. Characterization of spray pyrolysed indium sulfide thin films [J]. Semiconductor Science and Technology, 2003, 18(6): 491-500.
[21] COJOCARU-MIREDIN O, CHOI P, WUERZ R, et al. Atomic-scale characterization of the CdS/$CuInSe_2$ interface in thin-film solar cells[J]. Applied Physics Letters, 2011, 98(10): 103504.
[22] BAR M, BARREAU N, COUZINIE-DEVY F, et al. Nondestructive depth-resolved spectroscopic investigation of the heavily intermixed In_2S_3/Cu(In,Ga)Se$_2$ interface[J]. Applied Physics Letters, 2010, 96(18): 184101.
[23] ROMERO M J, JONES K M, ABUSHAMA J, et al. Surface-layer band gap widening in Cu(In,Ga)Se$_2$ thin films[J]. Applied Physics Letters, 2003, 83(23): 4731-4733.

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