Accepted Manuscript

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PII: S0925-8388(18)31096-X

DOI: 10.1016/j.jallcom.2018.03.226

Reference: JALCOM 45456

To appear in: *Journal of Alloys and Compounds*

Received Date: 16 December 2017

Revised Date: 16 March 2018

Accepted Date: 17 March 2018

Please cite this article as: J. Wang, S. Liu, Y. Mu, L. Yang, J. Yang, S. Feng, M. Shi, W. Yang, W. Fu, H. Yang, Sodium citrate complexing agent-dependent growth of n- and p-type CdTe thin films for applications in CdTe/CdS based photovoltaic devices, *Journal of Alloys and Compounds* (2018), doi: 10.1016/j.jallcom.2018.03.226.

Sodium citrate complexing agent-dependent growth of n- and p-type CdTe thin films for applications in CdTe/CdS based photovoltaic devices

Jun Wang [a], Shurong Liu [a], Yannan Mu [b], Lihua Yang [c], Jiandong Yang [a], Shuang Feng [a], Mengmeng Shi [a], Wenshu Yang [a], Wuyou Fu [a] and Haibin Yang [a,*]

[a] *State Key Laboratory of Superhard Materials, Jilin University, Qianjin Street 2699, Changchun 130012, People's Republic of China*

[b] *Department of Physics and Chemistry, Heihe University, Heihe 164300, PR China*

[c] *Key Laboratory of Functional Materials Physics and Chemistry of the Ministry of Education, Jilin Normal University, Changchun 136000, PR China*

Keywords: CdTe; n-type; p-type; sodium citrate; solar cell

Abstract: A uniform and compact CdTe thin film is successfully electrodeposited on Ni flexible sheets. The influence of the concentration of sodium citrate in the growth solution on the morphological, compositional and electrical conductive properties of CdTe films is investigated. The results show that sodium citrate plays a significant role in directing the morphological evolution of CdTe from three-dimensional rod-shaped array to two-dimensional thin film. The composition of the film is changed from Te-rich to Cd-rich, and the conversion from p-type conduction to n-type in CdTe films is also achieved with the increase of sodium citrate concentration. When the concentration of sodium citrate is 0.08 mol L^{-1}, the composition of CdTe film is near stoichiometric and the amount of excess Te is small. Furthermore, the effect of sodium citrate on the photoelectric conversion properties of CdTe-based solar cells is also analyzed. The fabricated solar cell based on the CdTe film prepared using 0.08 mol L^{-1} sodium citrate shows a short-circuit current density of 10.46 mA cm^{-2} and an open-circuit voltage of 0.53 V, yielding a better energy conversion efficiency of 2.73% with a fill factor of 49.28%. The better energy conversion efficiency is 2.1 and 1.6 times higher than that of the devices based on CdTe films prepared using 0.07 and 0.09 mol L^{-1} sodium citrate, respectively. This study indicates that the as-prepared CdTe thin film has a great potential for application in thin film solar cells, and the sodium citrate-assisted synthesis of CdTe film suggests a promising technique for large-scale fabrication of flexible solar cells.

1. Introduction