Based on the Internet of things a self-cleaning solar power system of the household micro-grid

Guannan Du[1], Xiuxia Zhang[1,2,*], ShuyiWei[1], Qianyu Ji[1], Haicheng Wei[1]
1 School of Electronics and Information Engineering, Beifang University of nationalities, Yinchuan,750021, China

E-mail: mhxymhzy@163.com

2.School of Instrument Science and Opto-electronics Engineering, HeFei University of Technology, Hefei,230009, China

E-mail: xxuazh@126.com

Abstract: As panels located in the wilderness and affected by the dust and sandstorm, photovoltaic efficiency was reduced by 30% - 40% after a period of time even worse. Based on the Internet of things the self-cleaning solar power system of the household micro-grid was designed in this paper. It included micro-grids and control systems; a self-cleaning solar power system of the household micro-grid was presented. Nano-diamond powder, ethyl cellulose, and solvent were mixed. They accorded to mass ratio of 1:3:24. The Nano-diamond slurry was got with a long time ultrasonic heating dispersed, which was adopted to prepare Nano-diamond film on the window glass of the solar cell to enhance self-cleaning capacity of solar power. The household micro-grid comprises a control system, solar panels, inverter, super capacitor. The micro-grid can make the electricity be intelligent deployment.

Key Words: micro-grid; Nano-diamond film; solar cell; conversion efficiency.

1 INTRODUCTION

Many scientists widely studied the specificity of the diamond. The results show that the diamond has high hardness, corrosion resistance, high temperature resistant, stable chemical and physical properties[1-4]. And the Nano-diamond has properties of self-cleaning[5]. On the one hand, it could ensure the light absorbed in, on the other hand, it could extend the service life of solar panels in dust environment. So Nano-diamond was chose to be the window of solar cell because of its excellent properties. Micro-grid was a new technology of distribution power system[6]. In this paper, a self-cleaning solar power system of the household micro-grid was presented. For the prior art of Nano-diamond film [7-9], the paper to provide a solar battery, high power efficiency, stable power supply from the household cleaning micro-grid solar power supply system.

2 THE DESIGN OF THE SYSTEM

Based on the Internet of Things， The self-cleaning solar power system of the household micro-grid.It included micro-grids and control systems; micro-grid which included surface preparation had solar panels Nano-diamond film solar panels connected to the output of the inverter and super capacitors, and it connected the inverse the output variable electrical load; super capacity output was connected to the inverter input terminal, an output terminal of electrical load and inverter input terminal was also connected with a conventional grid; electrical control system comprises means for selecting an access power load type of power microcontroller, respectively provided electrical power collector load and solar panel, set up in the SCM monitoring terminal and the output of the data transceiver module; microcontroller inputs connected to the output of the power collection, data transceiver modules used by GSM network was connected to the Internet to upload monitoring data.

3 THE DESIGN OF THE NANO-DIAMOND FILM SOLAR PANEL

The process of preparing Nano-diamond film: First, the glass substrate was cleaned by detergent, alcohol and demonized water and put in a cleaning environment. Nano-diamond powder, ethyl cellulose, and solvent were purified,and it accorded to mass ratio of 1:3:24. The Nano-diamond slurry was got with a long time ultrasonic heating dispersed, which was adopted to prepare Nano-diamond film on the window glass of the solar cell.

To prepare Nano-diamond films by special thermal sintering and post-processing was to ensure the uniformity of the films[10-12]. Thermal sintering treatment has two objectives: on the one hand, it can make the Nano-diamond films dry and firmly bonded to the substrate, on the other hand, it can make the films contained in the ethyl cellulose material decomposition evaporate. Thermal sintering process included two heating stages, two stages of constant temperature and a cooling stage. First it was heated up to 340K for 25 minutes, and then to 400K for 100 minutes, then to maximum temperature 600K for 60minutes, and natural cooling to room temperature at last.

4 EXPERIMENTAL RESULTS AND ANALYSIS

Thin film coated glass substrates were covered in the solar cell surface, and the photovoltaic conversion efficiency was obtained by I-V test. Firstly, we tested the effect of the clean film on the photovoltaic conversion efficiency of solar cells.Secondly, the glass substrate was exposed to the

This work was supported by National Natural Scientific Fund of China (No.51365001 & No.61461001).

outside. A month later, the glass substrate covered a lot of dust, once again test their impact on the conversion efficiency of solar cells.

A comparison test of the clean glass substrate with the glass substrate exposed to a month of exposure, as shown in table 1. The self cleaning effect of the solar cells covered with Nano-diamond films glass substrate was very significant.

Table 1. Table of photovoltaic conversion efficiency of solar cell for self cleaning thin film.

Photovoltaic conversion efficiency of solar cells	Clean	After a month of outdoor exposure
Uncoated glass substrate	17.66%	10.59%
Glass substrate of Nano-diamond films by sol gel	17.49%	15.77%

5 CONCLUSION

Compared with the prior art, the system has the following advantageous technical effects: Herein family self-cleaning micro-grid solar power systems, through a number of power acquisition to achieve electrical load and solar panels power information in real-time acquisition. The system used single-chip processing power comparison of the data, to ensure that while the multi-channel data acquisition, processing and sending, improve work efficiency, reduce system cost, ensure the accuracy of data collection and processing, to achieve the electrical load was reasonable under the power supply to ensure electrical work under the premise of supply and demand balance of power between the requirements to achieve full and efficient use of solar-powered. And the system was capable of timely transmission via GSM network to the Internet, the use of monitoring data terminal for access to complete monitoring of the family situation and electrical micro-grid power load conditions. And through the use of surface preparation has solar panels Nano-diamond film solar cells to achieve self-cleaning function, improve the system for solar energy conversion and utilization. Chemical properties of Nano-diamond stability, high temperature and corrosion, reduce corrosion of the external environment exposed in the outer solar cells, solar prolong battery life, and self-cleaning ability of Nano-diamond films to ensure the sunlight the amount of light. Further, the use of the corresponding connecting radio transmission module, so that the data can be transmitted in time and the transmission, and the realization of the wireless transmission module reset control signal communication and reliable.

ACKNOWLEDGMENTS

The project was supported by National Natural Scientific Fund of China (No.51365001 & No.61461001); Master Degree Candidate Innovation Fund of Beifang Univesity of Nationalities; 2015 Basic Scientific Research Project of Beifang Univesity of Nationalities(No.2015JBK338 & No.2015JBK346 & No.2015JBK357).

REFERENCES

[1] Himpsel F J, Knapp J A, Vechten J A Van, et al. [J].Phys Rev B,1979, 20: 624-628.

[2] Spitsyn BV,Boilov L , Derjaguin B V, [J] Crystal. Growth 1981, 52: 219-225.

[3] Matsumoto S, Sato Y, Kamo M, et al. [J] . Appl.Phys, 1982 ,21:183-188.

[4] Kamo M, Sato Y, Matsumoto S, et al. [J] .Crystal Growth, 1983, 62: 642-646.

[5] Verma,L.K.;Sakhuja,M.;Son,J.;Danner,A.J.;Yang,H.;Zeng, H.C.;Bhatia, C.S..2011.Self-cleaning and antireflective packaging glass for solar modules.[J]Renewable Energy, 2011,36(9):2489-2493.

[6] Lasseter, R.H. ; Paigi, P. .2004.Microgrid: a conceptual solution.Power Electronics Specialists Conference, 2004. PESC 04. 2004 IEEE 35th Annual ,6:4285 – 4290.

[7] Xiuxia Zhang， Shuyi Wei, et al. Application of printed Nanocrystalline diamond film for electron emission cathode [J] Applied Surface Science 2011.3(257) 5185–5189.

[8] Xiuxia Zhang，Erlei Wang，Xiaocong Yang. Design and simulation of Nano-diamond film pressure sensor ； [J]Vacuum，2014.Volume 99, Pages 189-191.

[9] Xiuxia Zhang,Junxia Wen.The Variable Super-Capacitor With Nano-Diamond Film Electrode [J] Applied Mechanics and Materials,2013. 11:93-97.

[10] Xiuxia Zhang,Changchun Zhu.Large area field emission for screen-printing Nanocrystalline diamond film, [J] TECHNICAL DIGEST IEEE IVNC2006.7:329-330.

[11] [Xiuxia Zhang,Bingheng Lu,Changchun Zhu.Electronic emission of transparent Nano-diamond film prepared by sol-gel method.TECHNICAL DIGEST IEEE IVNC 2010.6, 151-152.

[12] Xiaocong Yang, Xiuxia Zhang, Xiuli Lou, Junxia Wen, Daojie Jiang.2014.Research on the Preparation and Conversion Efficiency of Solar Cell Window Layer.Sustainable Energy,Vol.4 No.02(2014)