Barrier Coatings and Stability of Thin Film Solar Cells

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Subcontractor: **Pacific Northwest National Laboratory**

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1. OBJECTIVES/APPROACH

The key objectives of the program are to develop low cost barrier coatings for CIS and CdTe solar cells and to develop an improved understanding of the effects of water on the stability of these types of cells. The scope of this work entails investigations of multilayer, barrier coatings for CIS and CdTe thin film solar cells, and studies of stability issues, particularly those related to moisture ingress. Investigation of barrier coatings on SSI and CSU devices will continue in an effort to establish effective approaches to encapsulate CIS and CdTe modules. Studies will also be directed towards issues concerning cost of the coating process. The program will be structured into three major tasks: (1) Barrier coatings and stability studies for CIS Solar Cells; (2) Barrier coatings and stability studies for CdTe solar cells; (3) Low cost coating process development.

2. PROGRESS FOR THIS REPORTING PERIOD

Studies of photoluminescence in CdTe solar cell structures continued. The objective of this effort is to determine if the PL spectrum for a CdTe device is affected by stress. In particular, we are interested in determining if moisture affects carrier properties. Samples studied were cell structures without back contacts previously provided by CSU. Figure 1 describes our approach to PL studies. This figure is repeated from the last quarterly report. An excitation wavelength of 580 nm was used and band gap emission observed for the excitation beam entering through the glass and through the CdTe side.

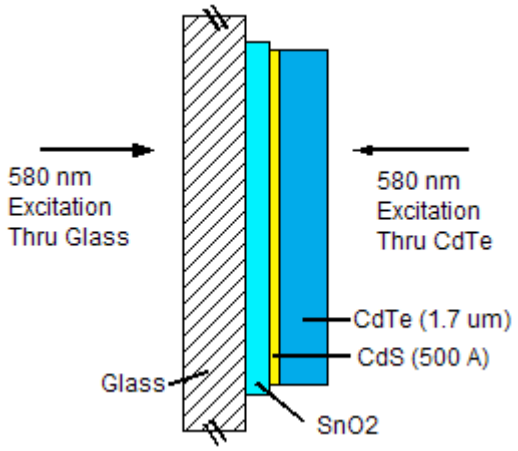

Figure 1. Sample configuration used for photoluminescence studies.

Results of PL studies carried out for a sample described by Figure 1 were presented in the last quarterly report. That same sample was then subjected to a stress of 60ºC and 90% RH for 1440 hours. PL measurements were then carried out to determine if a change occurred in the effective lifetimes. Results are summarized in Table 1.

Table 1 -- PL Results for Stressed CSU CdS/CdTe Cells

Excitation Mode	Effective Lifetime
Unstressed Sample	
Excitation Through Glass	475 psec
Excitation Through CdTe	300 psec
Stressed Sample	
Excitation Through Glass	335 psec
Excitation Through CdTe	Weak Signal

Results obtained for excitation through glass such that the incident light enters the CdS/CdTe junction side of the cell structure are interesting. These results strongly suggest that the effect of moisture is to introduce recombination sites in the depletion region causing a reduction of carrier lifetime. This change can, of course, affect both Jsc and Voc. The value of Voc for CSU cells are typically in the range of 0.75 to 0.80 Volts.

It is interesting to compare our results to those obtained by Metzger, et al. [1]. The PL lifetime was measured for a large number of CdTe cells. The value of Voc was found to increase with the PL lifetime. A cell with a PL lifetime of approximately 475 psec would be expected to provide a Voc of 0.75 Volts to 0.80 Volts, whereas a cell characterized by a PL lifetime of 335 psec would be expected to produce a Voc value < 0.75 Volts. For another comparison, we consider results obtained for a bare CSU cell, # 3 - 5- 2. Properties of this cell are shown in Figure 2. The Voc at beginning of life was 0.8 Volts, suggesting that the PL lifetime was ~ 800 psec. After 1000 hours of stress, the Voc decreased to 0.68 Volts. In this case, it appears that the stress caused the lifetime to decrease below 200 psec.

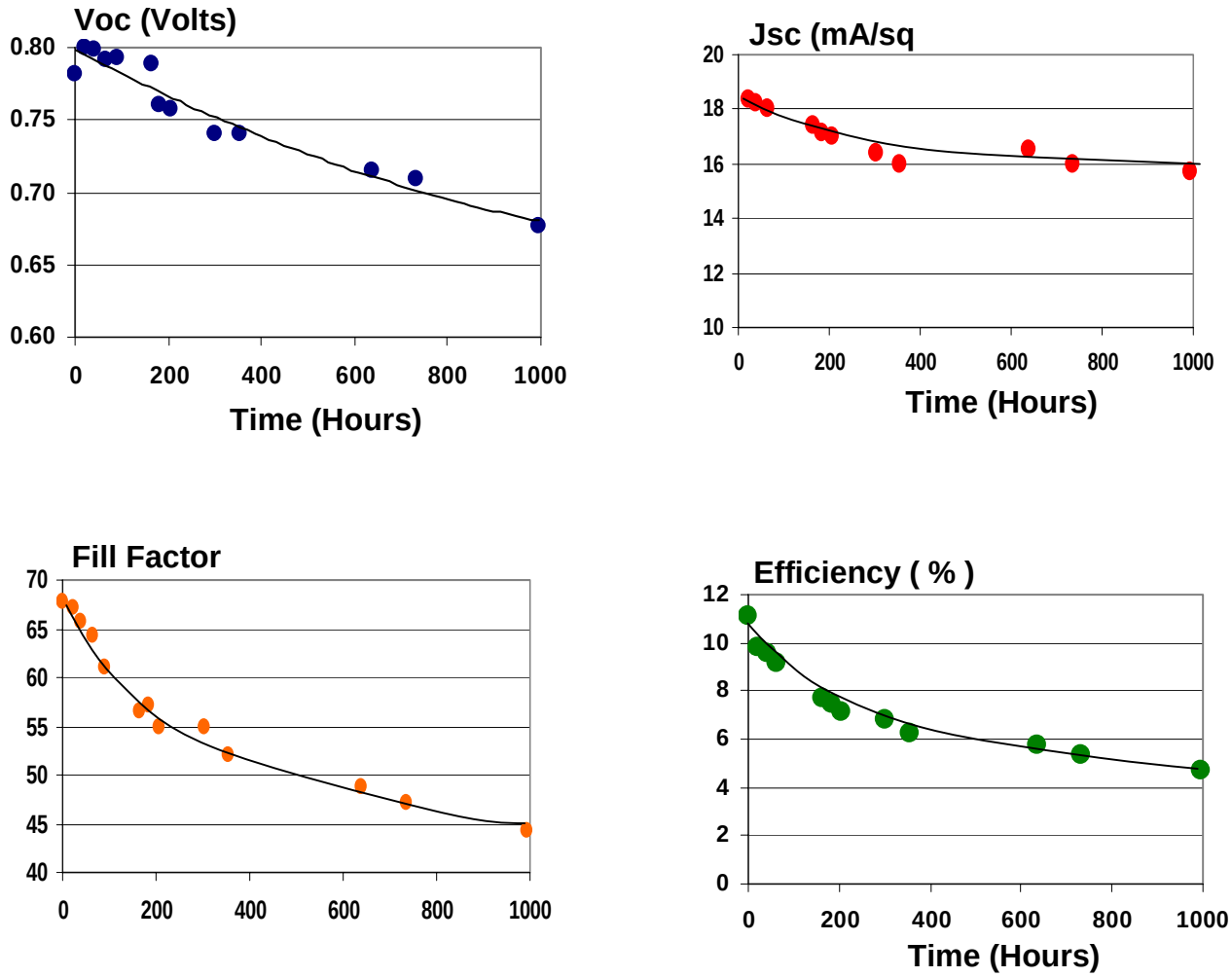

Figure 2. Cell properties for a bare CSU CdTe cell (# 5-2) subjected to 60ºC and 90%RH.

3. FUTURE WORK

Further studies of the effect of temperature and humidity on CdTe PL lifetime will be carried out. Our primary goal is to acquire information concerning the effect of moisture in the CdTe cell structure. Similar investigations will also be initiated for CIGS cells that were previously provided by Shell Solar.

REFERENCES

1. W.K. Metzger, et al., "Time-Resolved Photoluminescence Studies of CdTe Solar Cells," JAP 94, 3549 (2003).