Project SOPHIA

PhotoVoltaic European Research Infrastructure

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Data Beneficiary

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JRA01: Quicker lifetime prediction through accelerated ageing tests and improved failure analysis procedure

D9.2– Round robin – definition of test samples and test procedure

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1. Executive summary

1.1. Description of the deliverable content and purpose

Three module types have been selected for long-term reliability testing: standard c-Si modules from Atersa, hetero-junction modules from Sanyo and c-Si modules made with a thermoplastic encapsulant. Test sequences have been defined, which allow the assessment of the degradation over time and the evaluation of the time-transformation functions for different degradation factors. The test sequences go beyond standard tests as defined by the IEC. The aim of the tests is to identify critical loads which can result in premature failure of modules, to provide data for lifetime prediction modelling and to compare the response of the different module technologies to the tests.

1.2. Deviation from objectives, corrective action

In the original planning of the work package, testing was to have been performed on small-scale samples manufactured at the partner institutes. A large number of institutes do not have the capacity for manufacturing such test modules and a greater interest was shown in testing devices that were readily available on the market. This is also in line with previous work in comparable project such as PERFORMANCE. This also has consequences for deliverable D9.3. This deliverable was planned as a review of component testing with a focus on interconnection technology and encapsulation. The deliverable will now focus on the t=0 performance measurements of the three module types that have been selected.

1.3. Technical progress

Modules have been purchased and a test plan has been made. Acquisition of the modules was originally planned to take place through an exchange of modules for performance data, but this proved to be difficult contractually. The parties that were approach demanded more control over experiments and use of the results than was acceptable to the partners. These negotiations resulted in a delay in starting the test plan and so of the work package.
To avoid wasting more time, a decision was made to purchase modules for testing to ensure that the test plan and use of results was free of any interference from suppliers. In total 90 modules have been purchased. The modules were limited to three types as a larger number would require a larger testing capacity that is available at the institutes. As it is, a number of tests will have to be performed at commercial test institutes due to the non-standard nature of the tests. Typically, the partner institutes only perform tests according to the IEC standards and use all their test capacity at these conditions.
Purchasing of the modules and use of commercial parties for testing has resulted in additional cost for the work package. This cost will be distributed among the partners and will require a limited reallocation of budget from hours to material. An amendment to the contract is going to be requested to the European Commission regarding this change of allocation.

1.4. Impact of the results

The results will show the different response of the different module technologies to the test plan. This will allow critical failure mechanisms to be identified and provide data for lifetime modelling. It will also provide input for adaptation of the IEC standards to make IEC testing more relevant to state of the art cell and module technology.

1.5. Dissemination activities carried out, planned

The results will provide input for suggestions to IEC TG82 WG2.

2. Technical sections

2.1. Sample selection

Three different types of module were selected for the test plan. These were:

30 c-Si modules from Atersa
30 hetero-junction modules from Sanyo
30 c-Si modules made with a thermoplastic encapsulant

The Atersa modules were chosen as reference modules. They contain c-Si H-pattern cells tabbed with standard tabs soldered to the cells. The encapsulant used is a fast cure EVA. The back-sheet is TPT and the glass is standard high-transmission solar glass. The hetero-junction modules were chosen due to the different cell technology and the module technology required ensuring reliability with these cells. The cells are known to be more sensitive to damp-heat requiring a moisture barrier in the back-sheet and better edge sealing than for a standard c-Si module. The modules made with a thermoplastic encapsulant were chosen as this type of encapsulant is becoming increasingly popular as a replacement for EVA. The advantages of the thermoplastic are that is allows greater flexibility in processing time and temperature and that it does not form acetic acid on degradation as is seen with EVA. It is a relatively new material for PV and testing will give an insight in to its performance outside standard IEC conditions.

2.2. Test procedure selection

Test sequences were defined, which allow the assessment of the degradation over time and the evaluation of the time-transformation functions for different degradation factors. The test sequences will include standard IEC test as a reference. Damp-heat will be performed at both higher and lower temperatures and humidity. Thermal cycling will be performed at different rates over different ranges of temperatures. The combination of UV and humidity will be extensively researched as will the combination of damp-heat and freeze-thaw. Mechanical loading at low temperatures in combination with thermal cycling will be included. The institutes that will perform the tests have been identified and are included in table 1. The test plan is expected to take one year to complete including characterisation. In addition to these tests, a round robin with samples of the three modules will be performed to check the characterisation equipment and procedures at the institutes.

Sample No	Test performed at	Test	Temperature/°C	Relative humidity (%)	UV	Test time intervals (hours) and number of cycles						
1	JRC	Dry UV	85	0	5	1000		2000		3000		4000
2	ISE	DH	75	85		1000				3000	3500	4000
3	AIT	DH	85	85		1000		2000		3000	3500	
4	ECN/NES	DH	95	95		1000	1500	2000	2500	3000		
5	ECN/NES	DH	95	85		1000	1500	2000	2500	3000		
6	ECN/NES	DH	95	70		1000	1500	2000	2500	3000		
7	ECN/NES	DH	95	50		1000	1500	2000	2500	3000		
8	ISE	Wet UV preconditioning 2000 hours followed by DH 85/85	85	50	4			2000 (DH85/85)		3000 (DH85/85)		
9	ISE	Wet UV preconditioning 2000 hours followed by DH 85/85	65	85	4			2000 (DH85/85)		3000 (DH85/85)		
10	AIT	TC	(-40 / 85)			200	400	600	Cycles			
11	ECN/NES	TC	(-40 / 20)									
12	ISE	Freeze-thaw	(-40 /40)	85		50	100	200	Cycles			
13	ISE	Freeze-thaw	(-40 /40)	85	Preconditioning 2000 hours DH 85/85	50	100	200	Cycles			
14	AIT	Mechanical loading	25			followed by TC200						
15	AIT	Mechanical loading	-40			followed by TC200						

Table 1 Test plan showing tests that will be performed on the modules and institutes which can perform the tests. For the damp-heat test at higher temperatures, commercial test institutes will be subcontracted to perform the tests

3. Conclusions

The samples have been defined and will be delivered in the coming months. The test procedures for the accelerated life tests have been designed and the institutes which can perform the tests identified. When the modules are delivered, the test plan will start with t=0 measurements which will be reported in D9.3. The results of the test plan will provide input for life time modelling and for IEC TG82 WG2 for adaptation of the test standards.

4. References

N/A