PV Industry Should Learn From History And Jointly Promote Sustainable Development

- By DuPont Photovoltaic Solutions

India PV industry has experienced rapid development in the last five years. Since the inception of JNNSM in 2010, PV installations in India have multiplied from a meager 300 MW to more than 8 GW in 2016. While the market growth has been fast paced, the reducing tariffs are imposing significant cost pressures on module manufacturers who, in order to generate short term profits and cash flows, are cutting costs by rapidly deploying technological changes in design, construction, and 'bill of materials', which have direct and significant impact on performance of modules in the field.

The situation of significant price drop of modules was witnessed in China in 2011-2012 owing to dual attack of anti-dumping duties and cost pressures from developers. Many manufacturers suffered heavy losses and adopted cost reduction strategies to make some profits and survive in the market. Proven materials were replaced by low cost unproven materials, compromising quality of modules. The impact was seen after a few years in the field when huge number of modules with unproven materials began to show large scale failures, significantly impacting the payback period and causing financial losses to the investors. India is observing a similar situation of significant price reduction by module manufacturers, primarily driven by aggressive bidding for solar projects. Lack of robust standards and mechanism to evaluate module quality allows module manufacturers to use low cost, unproven materials which, as seen in China's case, pose substantial risks on module performance and returns on investment. This practice has the potential to jeopardize credibility of India's PV industry at this critical juncture in its development.

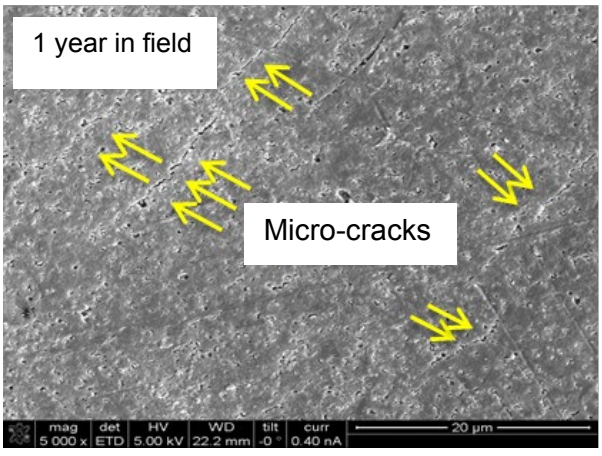
To avoid this, India's PV industry needs to learn from experienced countries like China and not repeat the same mistakes by ensuring use of good quality proven materials in the modules to promote long term health and sustainable development of the industry.

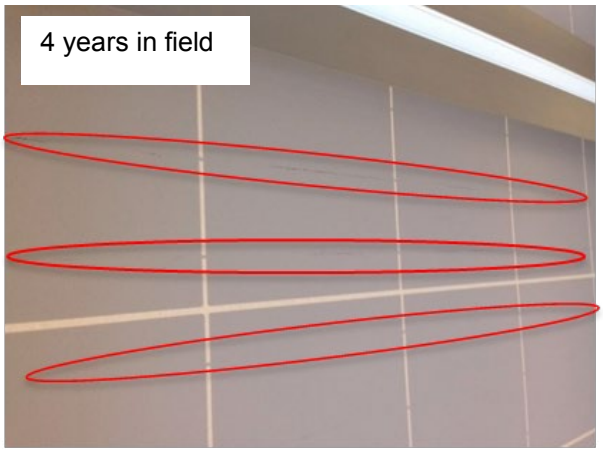
A real case study from China

In 2012, a PV power plant was successfully commissioned in western China and connected to the grid. the initiative generated a lot of excitement among stakeholders, and raised hopes of the entire PV industry for a better future of solar in China.

However, in 2013, hopes began to fade when a random testing of the modules demonstrated large number of micro-cracks on the surface of module backsheet.

In a re-inspection of the plant in 2016, the defect (backsheet micro-cracks) was found to have worsened – cracks increased in number, became longer, wider, and deeper, more cracks developed along cell bus-bars – resulting in significant current leakage issues. The O&M team alerted about safety risks and initiated warranty claims with module manufacturers.





This is not a standalone case of backsheet cracking in China. By 2016 the industry began to hear about more and more cases of backsheet cracking in only 4-5 year old installations. Not only China, backsheet cracking instances have been found in less than 5-year old solar plants in Europe and Southeast Asia. Module manufacturer had to replace these modules under 10-year product warranty which caused huge financial losses and set back to the company's credibility in the market. Developers and other stakeholders were baffled about – how can these modules, certified as per international norms, fail and demonstrate quality issues at such early stage? Doubts were raised whether these certifications were robust enough to evaluate module's quality and ability to perform in outdoor environment and harsh conditions for 25 years.

The Root Cause

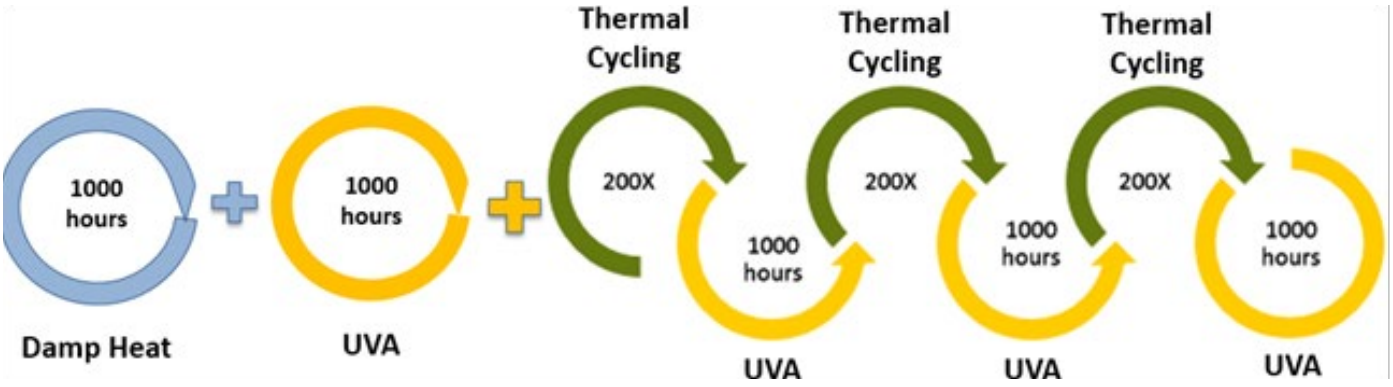
PV modules are required to be designed to perform for 25 years in outdoor conditions. The materials used in a module are responsible to protect it and should be capable to withstand challenging climatic. In particular, the backsheet – which is the outermost layer of a PV module and most important component as far as environmental protection of module is concerned – should be highly durable and reliable. Being directly exposed to environmental stresses such as UV, wind, sand, and temperature changes, backsheet materials are most prone to ageing problems and degrade quickly if they are not selected carefully. Due to lack of test methods and standards to evaluate long term aging performance of PV modules, materials of varying qualities are able to pass existing certification testing. This results in failure of materials which are not capable to withstand outdoor exposure for long term. To prevent this, industry urgently needs to develop better testing standards to more accurately predict long term reliability and performance of the backsheet materials.

Optimized Test Method

Firstly, the conventional test methods currently used by the industry are single-stress tests. These tests do not simulate actual conditions outside where multiple stresses (UV, heat, humidity, temperature changes) occur simultaneously, and thus do not reflect actual ageing of materials in field conditions.

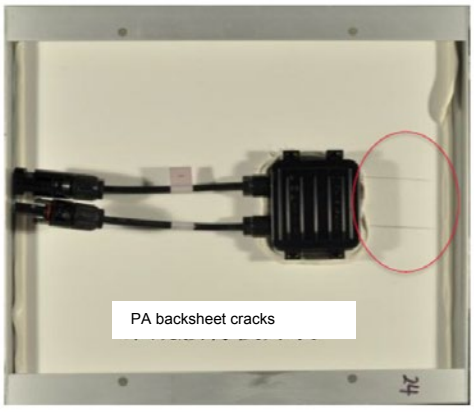
Secondly, some of the tests are underperformed in existing standards and thus do not reflect the risk associated with backsheet material during warranty phase. For example, the cumulative UV dosage for 25 years on backsheet is approximately 275 kWh/m2 in harsh desert climates, and approximately 170 kWh / m2 even in mild climates. However, current certification requires only 15 kWh/2 UV dosage (only front side) which simulates only ~70 days of outdoor exposure. Finally, the current tests do not evaluate change in backsheet mechanical properties after ageing. The outdoor failure of backsheet often occurs due to degradation of its mechanical properties after prolonged exposure to UV radiation and damp heat conditions. In order to better simulate the impact of outdoor conditions of backsheet material and assess its long-term ageing performance, the accelerated test should reflect the situation of outdoor ageing test sequence, and should be done on the same set of samples.

Sequential Aging Test

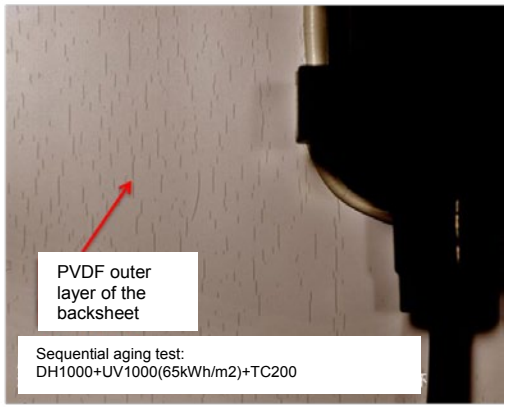


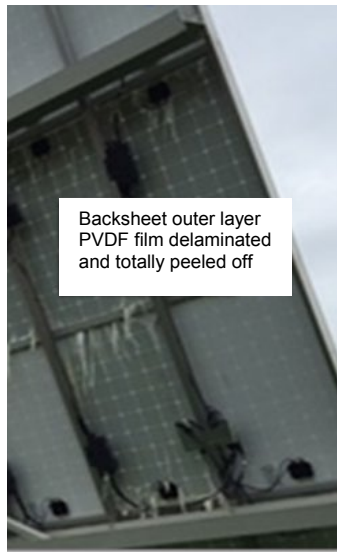
For example, the given sequential ageing test was conducted on PVF and PVDF based backsheets. After the test, PVDF backsheet cracked along transverse direction. This happened due poor mechanical properties of the PVDF film which becomes brittle after exposure to damp heat conditions (refer figure – shows complete loss of elongation of PVDF film after only 500 hrs of damp heat exposure). Comparing this result with that observed in the field, one can see a good correlation between recommended sequential testing and field data as both of them show cracking of outer PVDF film in the backsheet. No cracking of degradation was seen in the Tedlar® PVF-film based backsheet.

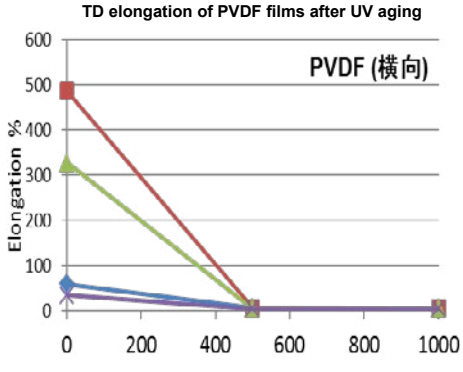
PA backsheet cracks after sequential aging tests, which simulates field failure mode.

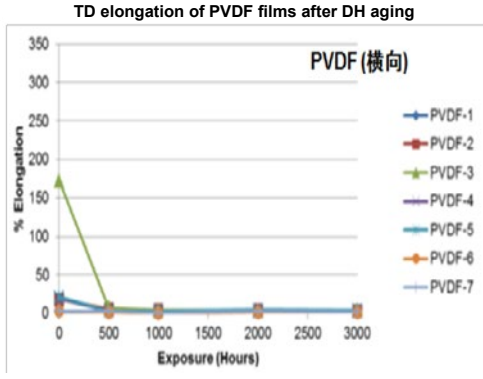


PVDF backsheet also shows cracking issue after sequential aging tests









This image is of a 4-year old installation in North America wherein ~57% of the modules demonstrated cracking and delamination in PVDF backsheet.

SUMMARY

Extended service life and low power degradation of PV modules is an important factor to reduce the cost of electricity and ensure return on investment. Field performance of PV modules is the ultimate basis of module selection, however, fast changes in module technologies, designs, and materials require dependence of accelerated tests to evaluate module quality. For PV backsheets, the recommended sequential testing should be widely used to evaluate long term reliability of different backsheet materials and provide a better source to module manufacturer for selecting good quality backsheets.