COMMON DEFECTS IN SOLAR PHOTO VOLTAIC MODULES

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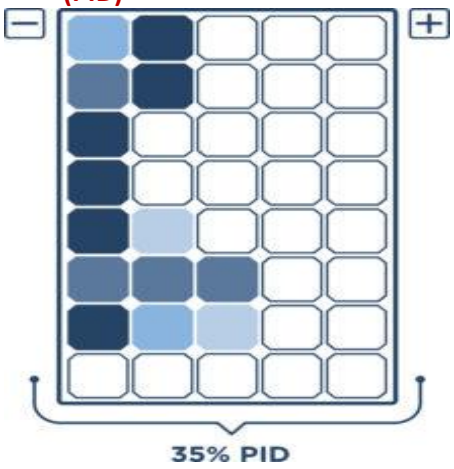
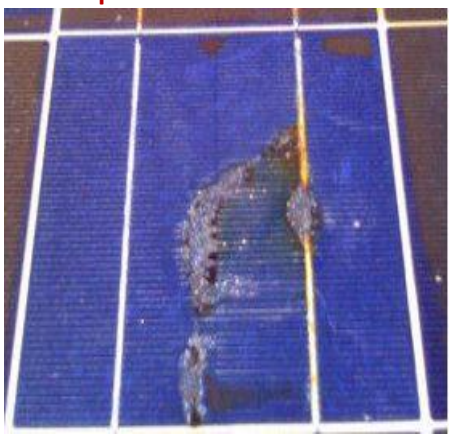
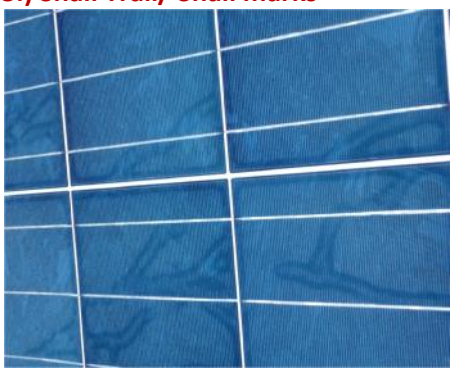
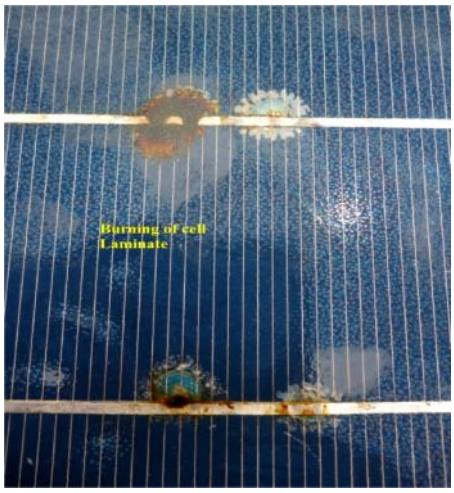
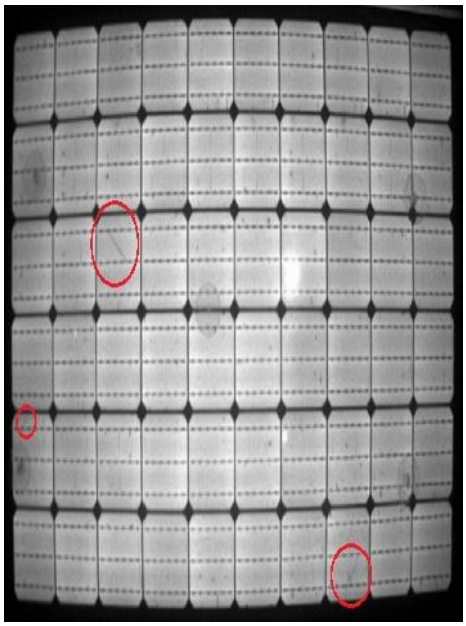
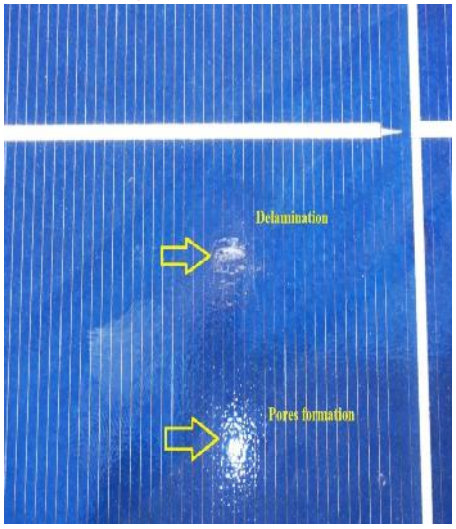
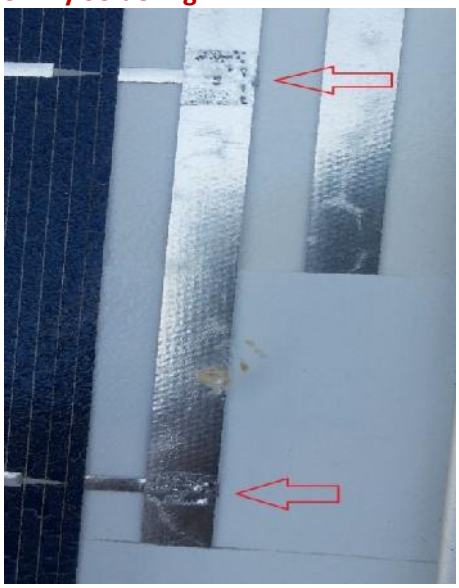
"We Strive To Make This Earth a Greener Place"

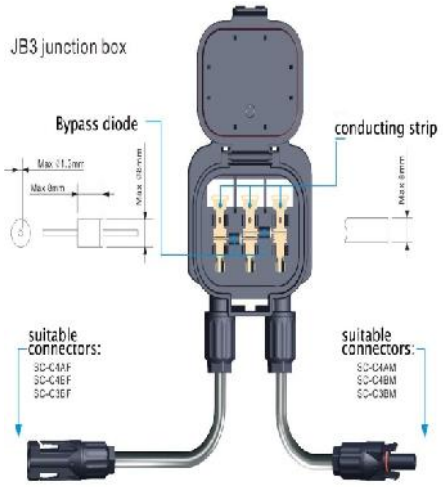
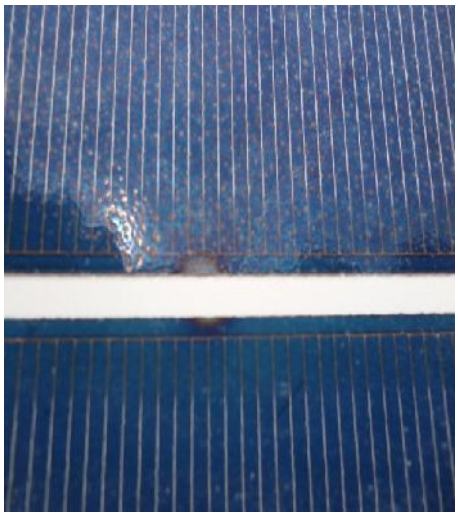
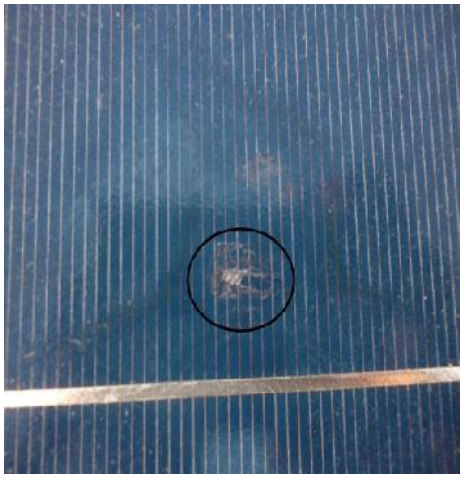
Defects in Solar PV Modules

Solar Panel is the most important component in a Solar Project and it comprises of more than 50% of the project cost. It converts solar radiation into electricity and hence plant's economics widely depend on type and quality of Solar Panel used. Hence, any project developer shall be aware of various defects that may arise in Solar panel.

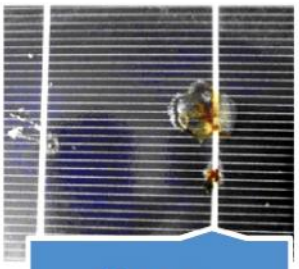
Defect Type & Image	Description	Analysis / Test/Certification
1. Potential Induced Degradation (PID) 	PID affect occurs most commonly in the PV module that is closest to the negative pole, during operation, the cell's voltage is negative pole voltage. In contrast, the frame of the PV module has 0 V, because it is grounded for safety reasons. This electrical voltage between the cells and the frame can cause the electrons to come loose from the materials used in the PV module, migrate into the electrical field, and then discharge through the grounded frame, this phenomenon is termed as potential induced degradation (PID).	It is strongly recommended to ensure the test certificate under IEC 62804 along with IEC 61215 and IEC 61853 and other Anti PID / PID free measures.
2. Hot Spot 	Hot-spot heating occurs in a module when its operating current exceeds the reduced short-circuit current of a shadowed cell or group of cells within it. The probable causes of hotspot formation are non-uniform illumination of the module (local shadowing), individual cell degradation due to cracking or loss of a portion of a series-parallel circuit due to individual interconnect open circuits.	• Hot spot endurance test under clause 10.9 of IEC 61215 • Mechanical load/cycling test under clause 10.16 of IEC 61215
3.) Snail Trail/ Snail marks 	It is a new phenomenon in crystalline PV Modules referred as one of the most common defect. It is nothing but the formation of Nano particles of silver carbonate on fingers of cells, thus de coloring the affected part and is shown as snail trail marks. The carbonate part is extracted from the already existing pores in the wafers as it has been found that these pores do possess CO_2 and O_2 elements within	To analyse the micro cracks we have to go for EL tests, snail trails can be visually seen in the affected modules.

4. De-lamination 	This phenomenon can be referred as removal of EVA from cell, it is resultant of worst quality of material used in manufacturing. Thus results in delaminating of the affected part. Wrong process parameters or cheap material can result in a de-lamination of the EVA later in lifetime. The layers of EVA dissolved and get a whitish color or color fading. Due to the de-lamination, moisture can get to the cell which leads to cell corrosion and an ongoing performance loss. Further, the light transmission is reduced.	Whitening /color fading as de-lamination in PV modules, Cells burnt after de-lamination
5.Oxidation 	Oxidation is a very common phenomenon, nothing but the corrosion of different parts of the PV modules viz. Fingers or Bus bars etc. De-coloring /Bronze coloring of Fingers are termed as oxidation; the factor involved due to which the oxidation phenomenon happens is moisture penetration within the modules. This moisture can enters through tedlar/back sheet, through glass or through any other open part of module.	Patch formation and browning of fingers as affected area of oxidation
6. Micro Cracks 	Micro cracks are one of the major and most adversely affecting defects in PV Solar industry. These are hairline and even narrow cracks formed in solar cells. These cracks are mainly formed during the encapsulation process/manufacturing process, yet there are least chances that such cracks may develop during conveying/transportation or during operations. Due to cracks the junctions within the cell acts as open circuit in affected area, thus reduces the efficiency drastically. Further these micro cracks also results in snail trail in some cases due to reaction with moisture.	To analyze micro cracks in Modules , Tests like Flash Test/ EL tests , Mechanical load test 5400 Pa , 200 humidity freeze cycle Under IEC 61215.

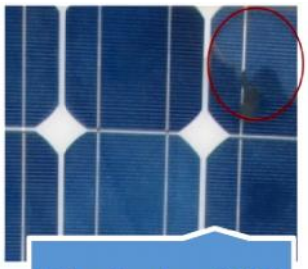
7. Glass Breakages 	Generally the glass used in crystalline Modules is Tempered glass, it is not that easy to break these glasses, yet in some situation due to external pressure these glasses can get broken. If the quality of glasses are not up to the mark, they may shatter due to thermal shocks too.	Easily observed by the user.
8. Bubbles / Pores formation 	This defect is also a result of bad quality of Manufacturing material used, Due to worst quality of Tedlar /back sheet, moisture penetrates within the cell and EVA and thus forms bubbles and pores after evaporation. Cells may burn at the affected area during course of time by this defect.	Sometimes during wafer manufacturing itself, pores reside within the cell. Visual inspection shall be done.
9. Dry Soldering 	This defect occurs due to improper soldering of Bus Bar and fingers on cell by unskilled resources or in absence of proper automation. This defect results in formation of hotspot, part area may induce high resistance thus burns the cell, EVA and tedlar/Back sheet.	• Some of the module manufacturing vendors do not impose required quantity of Silver paste to reduce costs, thus gives defects while manufacturing. • Due to dry soldering Bumps/ De lamination can also be seen in some cases.

10. Burning of diodes /displacing of junction boxes 	Since diodes (Bypass/ blocking) are one of the most important elements of crystalline PV modules. Due to material quality defect or improper capacity sizing or loose connection they get burnt, thus degrading the module efficiency . We must always prefer automated unit for module manufacturing.	• Due to unskilled resources or bad quality of adhesive the junction boxes gets displaced. • The diodes shall strictly follow specific codes viz IEC 62548.
11. Visual defects 	These defects do not impose any efficiency/generation degradation in the modules. Cells from some manufactures show dark markings on the edge of the cell. These spots are due to the specific production process and not have any negative influence to the performance or life time of the cell , provided they are not covering the conversion area of panel and not blocking the solar radiation.	These defects are included under clause 10.1 in IEC 61215
12. Defects Due to Mis handling at site 	These are most common defects that can be easily avoided provided care must be taken during PV module installation. Glass Breakages is the most common of all defects under this category & should be taken care to avoid formation of micro cracks within. Avoid pasting of stickers on cell area, and paint/cement/concrete residuals should be properly washed out so that no formation of hot spots take place there.	Modules must be properly placed/mobilized/installed.


Snail trails


Hot spots

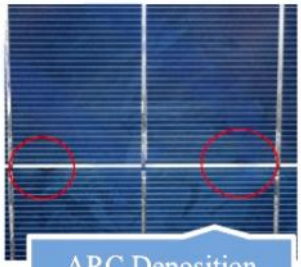

Backsheet chalking


Delamination of EVA


Browning of EVA


Micro Delaminations


Backsheet puncture


ARC Deposition marks

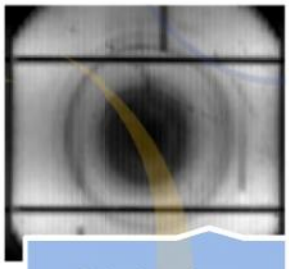

Melted JB's

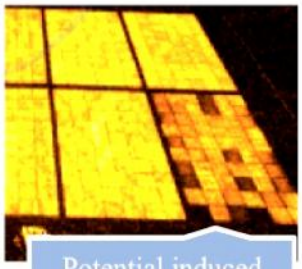

Connector failures


Frame misfit

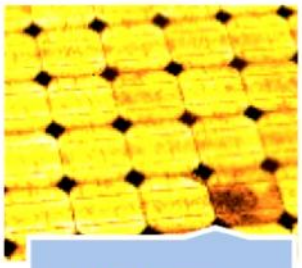

Junction box adhesion


Corrosion of interconnects


Striation rings

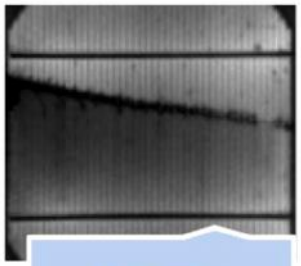

Potential induced degradation


Soiling of edges


Hail impacts


Corossion of fingers and busbars


Backsheet delamination


Cels cracks