solar gators	**Solar Array**	**Prepared by**	Toan Nguyen
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Owner	Solar Gators	**Last Reviewed/Update Date**	

Standard Operating Procedure (SOP): Encapsulation

1. Purpose

This SOP outlines the steps taken to handle and encapsulate a solar array module.

2. Scope

This SOP is for the solar array subsystem when manufacturing the solar array or anyone else who is involved in manufacturing the solar array.

3. Safety/ Hazards

- The materials must be kept as clean as possible
- Solar modules are very fragile, handle with care
- Materials get very hot (~140 ºC)
- Gloves
- Safety glasses
- Close toed shoes

4. Control

1. At least 2 people are needed

5. Procedure

1. Place several layers of felt on table surface.
2. Place the heating pads on top of the felt.
3. Place the aluminum plate over the heat pads.
4. Clean the aluminum plate very well with acetone.
5. Roll the tacky tape out around the perimeter of the aluminum plate, leaving the paper on.
6. Cut and place a piece of FEP on the aluminum plate. Perform this step immediately before the next layers are ready to go on so the FEP doesn't collect dust. Roll the FEP from under the roll so the part of the film that faces outward on the roll touches the aluminum.
7. Place the first sheet of TPO on top of the FEP with the smooth side of the TPO facing the cells.
8. Place the solar cells face down on the TPO.
9. Place the second sheet of TPO on top of the cells, aligning it with the first sheet. The smooth side of the TPO faces the cells.
10. Place the backsheet on top of the TPO, oriented with the shiny side facing the aluminum plate.
11. Place the blue release film over the backsheet.
12. Place the breather over the release film. The breather should cover the aluminum plate to the tacky tape or else the vacuum bag will get wrinkles that trap the air and prevent the pressure from getting as low as it should.
13. Place vacuum port over breather in an area where it will not be on top of the backsheet or else the module will get an indent in the back.
14. Cover the aluminum plate with the vacuum bagging.
15. Remove the paper from the tacky tape and stick the vacuum bagging to the tacky tape. Make sure there are no holes.
16. Cut a small slit where the port hole is and connect it to the vacuum hose.
17. Turn on the vacuum and listen for holes.

18. Monitor the pressure of the vacuum until the gauge reads –28. When the pressure reaches –28, the pitch of the vacuum will noticeably change from a gurgling to a consistent sound. Less smoke will also come out of the vacuum when the pressure is sufficiently low.
19. Put on wood block on diagonal corners of the aluminum plate and put the long wood block across them. Clamp the blocks to the table to prevent the aluminum plate from bending during the heating process.
20. Turn on heat pads to 140 degrees Celsius.
21. Start a timer for 20 minutes.
22. Monitor the temperature of the cells. If there is uneven heating (a difference of at least 10 degrees), hold felt over the cooler areas to trap the heat and increase the temperature in those areas.
23. Rotate the aluminum plate 180 degrees around the hallway point to further ensure even heating.
24. Turn off the heat pads.
25. Turn off the vacuum when the temperature when the temperature of the cells reaches 60 degrees Celsius or less.
26. Remove the bagging and take out the encapsulated module.
27. Repeat.

6. Definitions

- **Felt**: pads of cloth to help protect table from getting burnt
- **Heating Pads**: flexible silicone heating pads for encapsulation
- **Acetone**: chemical used to clean
- **Tacky tape**: yellow putty tape used for adhesion
- **FEP (Fluorinated Ethylene Propylene)**: thin, clear film used for flexible solar cell light transmission
- **TPO (Thermoplastic Olefin)**: slightly opaque, thick film used for flexible solar cell protection
- **Backsheet**: stiff, white sheeting used for the base of the solar array modules
- **Release film**: blue porous film used to keep the vacuum bagging and the solar array modules separate
- **Breather**: cotton-like material rolled into a sheet used to facilitate air movement and wrinkle-free vacuuming when encapsulating
- **Vacuum Bagging**: thick, plastic film used to seal the solar array module for encapsulation

7. References

2018-2019 Knowledge Retention Document, Solar Array, by Kelly Fox