MELCO's Solar Power Module (SPM) Development

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1. Introduction

SAP(Solar Array Panel) is a main electrical power source for space satellites and spacecrafts, and typically consists of strings of CICs (coverglass interconnected cells), laid down onto a substrate with polyimide film on front side (Fig.1). A Unit of string is called "solar cell module".

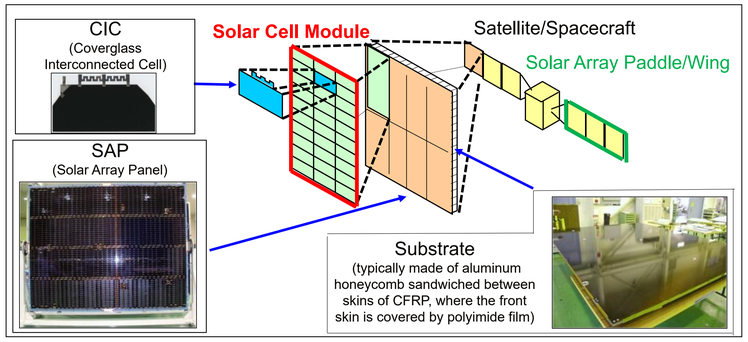

Fig. 1. Illustration of SAP and its Main Parts Terms

2. MELCO's SAP Heritage

Since 1976, MELCO has been designing and manufacturing rigid SAPs for various needs from domestic and overseas customers.

Table. 1. MELCO's SAP in Orbit

SolarCell Type	Orbit Type	Quantitiy of SAP in orbit	1st Flight Year
Single Junction	GEO, LEO	650	1993
Dual Junction	GEO, Lunar	30	2002
Triple Junction (4inch Wafer)	GEO, LEO	1010	2006
Triple Junction (6inch Wafer)	GEO	10	2020
Quad Junction (6inch Wafer)	GEO	12 SAPs are expected to be launched in 2023.	

The list of MELCO's SAP in orbit is shown in Table.1.
Starting from single junction high efficiency silicon solar cells made of 4-inch semiconductor wafers, MELCO's rigid SAPs cover the wide range of solar cells for space use. Single-, dual-, and triple-junction GaAs solar cells on MELCO's SAP are in orbit. SAP with quad-junction GaAs solar cells from 6-inch wafers was manufactured and is planned to be launched in 2023.

Furthermore, for lunar mission requiring higher power per unit mass, MELCO developed solar array panels with solar power modules manufactured by domestic solar cell supplier. The solar array panels are developed and its flight is planned in 2023 (Fig. 2).

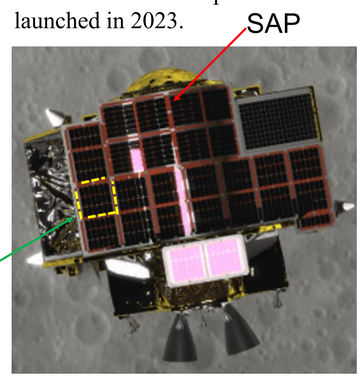

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Fig. 2. First Spacecraft built by MELCO with SPM [1]

3. Motivations of Developing SPM

Recent improvements in flex-type solar array architectures have benefitted satellites requiring solar arrays with greater electrical power, lighter weight, more compact stowed volume, and lower cost. MELCO has been adopting higher efficiency solar cells for solar arrays and has been developing SPM to meet various demands from flexible solar array manufacturers and users (Fig. 3).

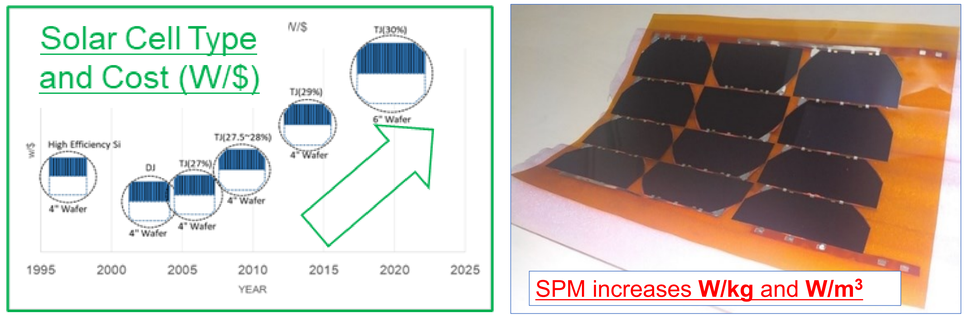

Fig. 3. SPM with High Efficiency Solar Cell

4. Mass Production Capabilities

MELCO's approach of Mass production is to utilize automated manufacturing machines of rigid SAPs for SPMs.



Fig. 4. SPM (Bottom) Manufactured Using Automated Machine (Top)

One example of automated manufacturing machine, for CIC welding, is shown in Fig.4. Just by placing solar cells and other parts onto a tray and pushing a button of the machine, welding process for CIC is performed. MELCO owns many in-house automated machines, which can be used for SPM as well. Existing automated manufacturing machines are planned to be used to ensure the steady and high production rate.
In addition to existing automated machine, the new automated machine is currently under production (Fig.5). This machine performs three processes: application of adhesive on solar cell modules, allocation of solar cell module onto the base film, and pressurization on solar cell module with heat-controlling weight.

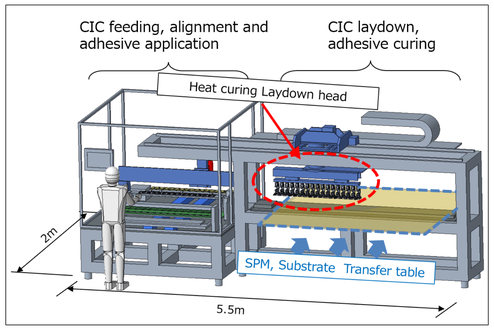

Fig. 5. Conceptual Design of the New Automated Machine for SPM Mass Production

5. New Solar Cell for SPM

MELCO has been investigating new solar cells on which MELCO's conventional manufacturing process can be incorporated. SPM design with new and more competitive solar cell was incorporated (Fig.6). The SPM was exhibited at Satellite 2023, Mar. 13-16 Washington, DC.

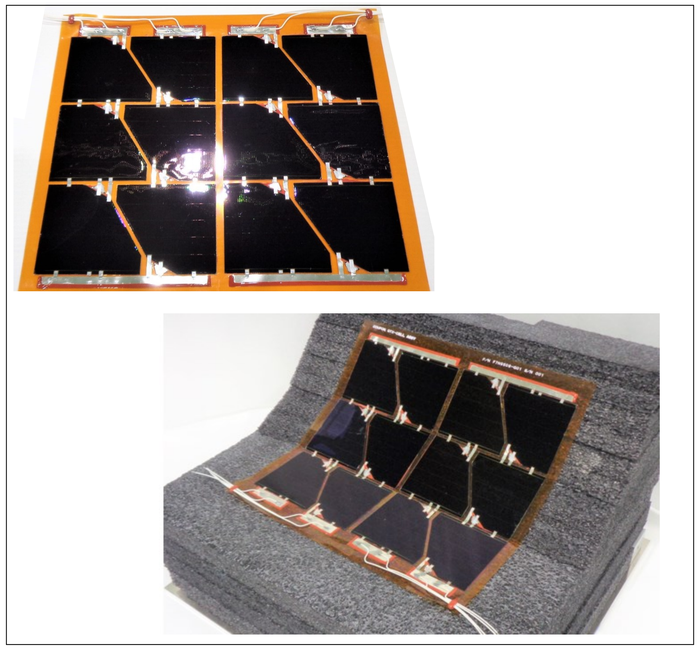

Fig. 6. Example of MELCO SPM Designs

The solar cell in the SPM is thinner than conventional ones, and several challenges were found during the manufacturing of above SPM. One example is the way to support ultra-thin solar cells during transportation, handling, and manufacturing. Improvements will be applied for automated manufacturing machine before mass production.

6. Future Development

Space industry is rapidly growing and diversifying. Moreover, new solar cell manufacturers of high tech startups are developing their solar cells on ground and are demonstrating their solar cells in orbit. Each mission requires different performances of SAP and SPM. ***In addition to the new solar cell shown in Sec.5, MELCO plans to select solar cell and to develop SPM which works best for each mission.***

7. Reference

[1] Image cited from https://www.isas.jaxa.jp/home/slim/SLIM/index.html

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