MYSAT-1 – The first UAE CubeSat with a remote sensing and technology demonstration payload

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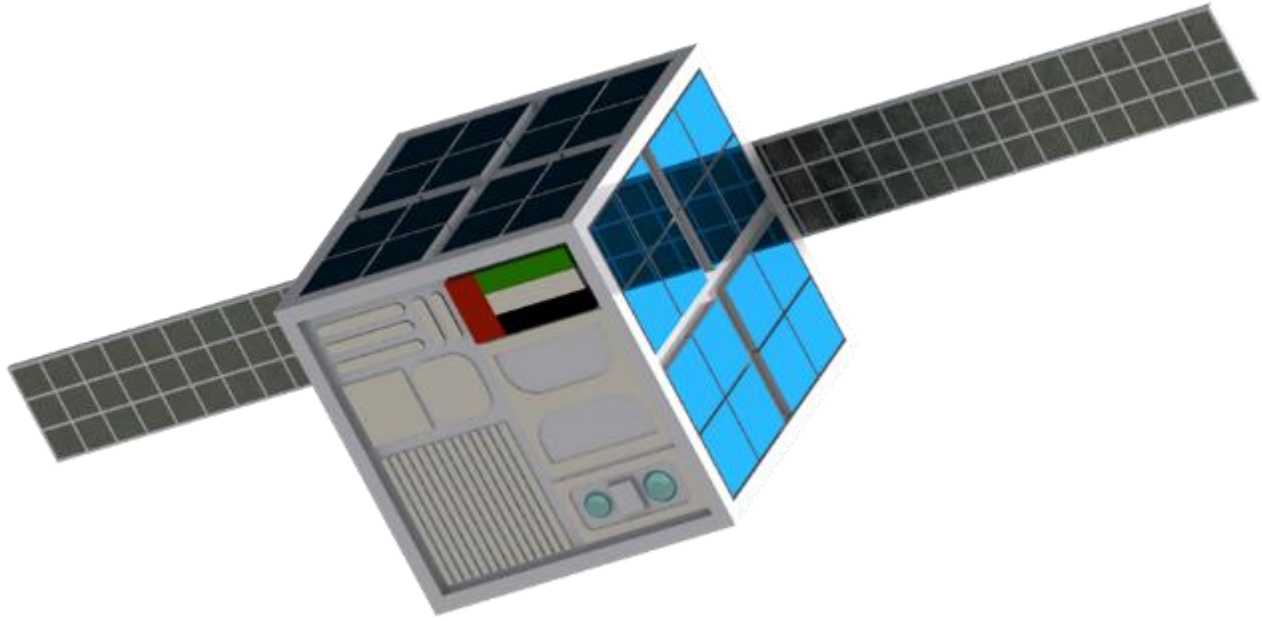
Outline

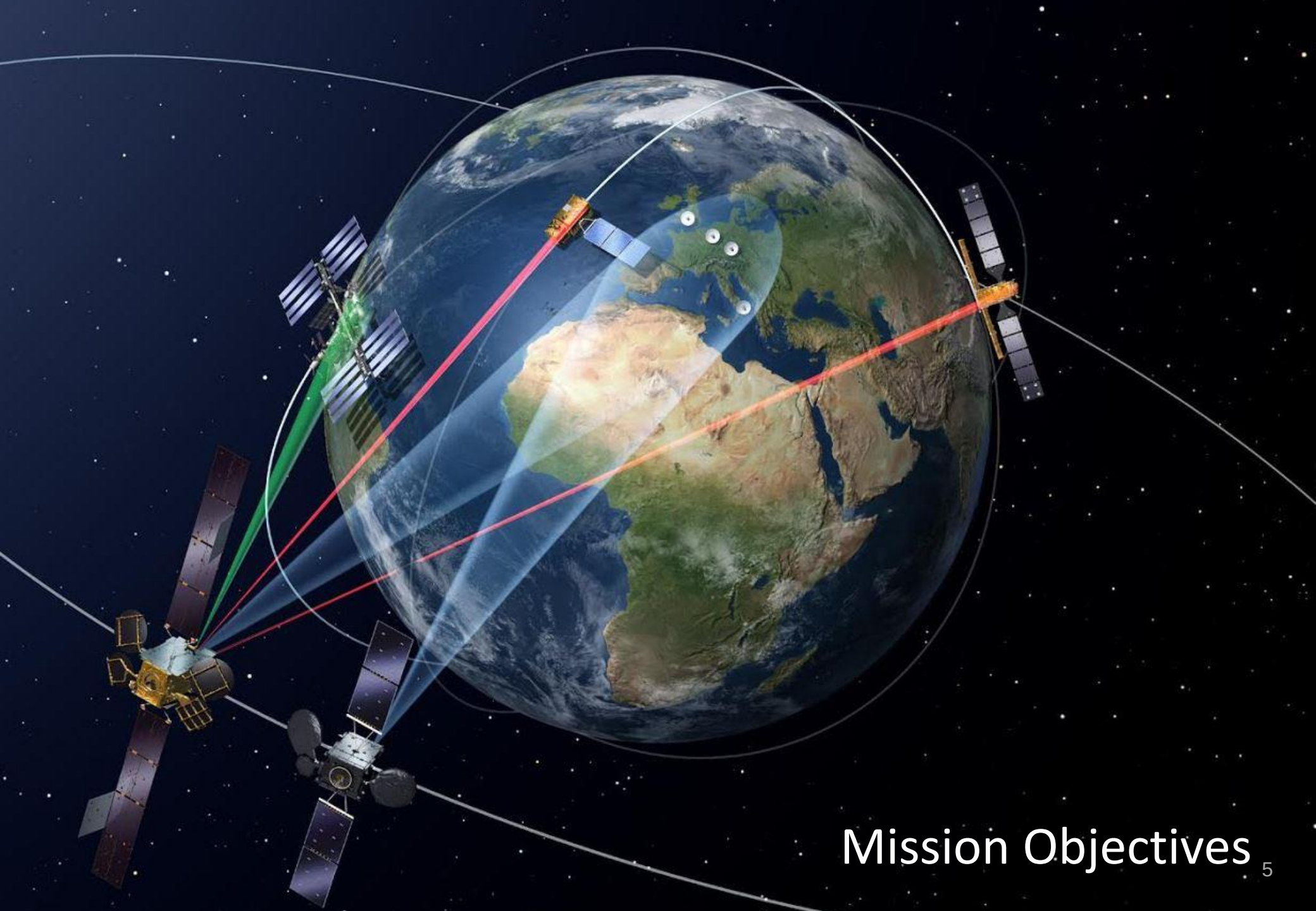
- Who We Are
- MSc Concentration Overview
- MYSAT-1 Mission Objectives
- Program Status
- CubeSat Design
- Other Research Activities

Who We Are

MSc Concentration in Space Systems and Technology

- Student-driven CubeSat project, part of a joint interdisciplinary graduate space program
- Foster the advanced research areas in space science and technology for development of UAE
- Establishing strong links between the space industry with academic institutions

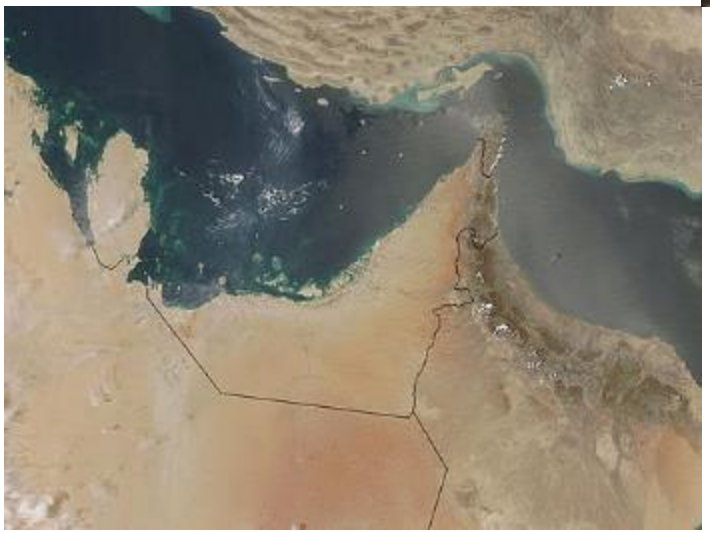




Mission Objectives

Mission & Mission Objectives

- Education
- Remote sensing
- Technology demonstration

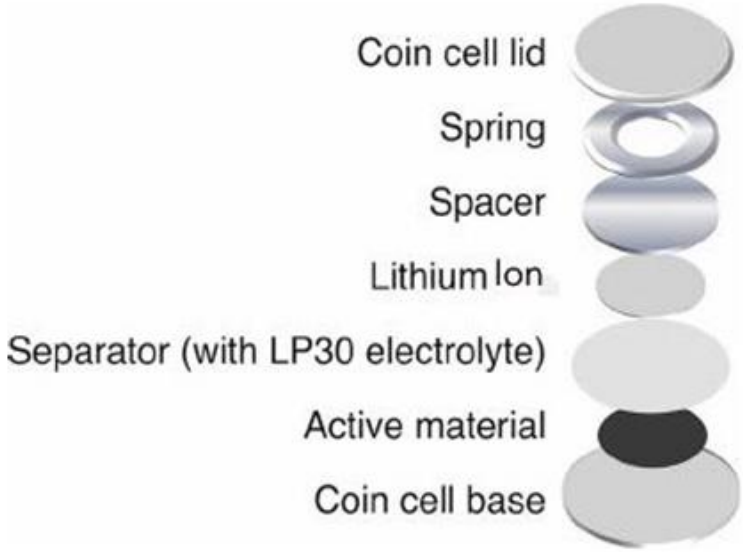


Technology Demonstration

The battery is a coin cell developed at Masdar Institute

The battery is split into two halves:

- One half containing the active Fe_2O_3
- Other half containing Lithium Ion



Technology Demonstration

Battery's performance will be tested in space based on State of Charge (SOC) and State of Health (SOH)

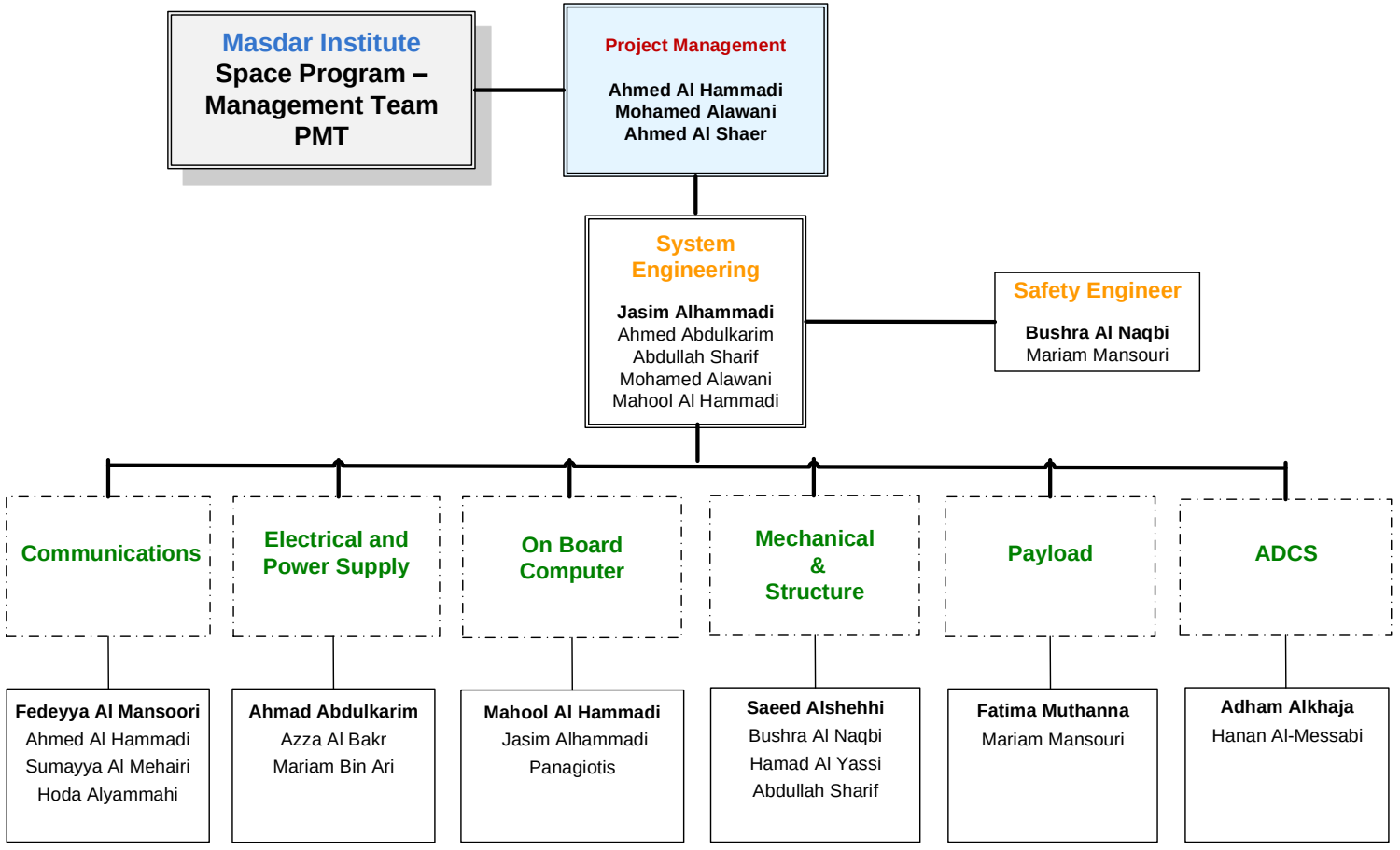
Model	Mass	Diameter	Thickness	Operating temperature range
2032-coin cell	4.01 g	20 mm	3.2 mm	-10 C to 80 C

Extra features	Able to be charge/discharge at high current rate (e.g. at 1C rate) and at the same time has higher specific capacity compared to graphite based anode.
Charge Procedure	Constant-current charge until 3.49 V reached, then constant-voltage charge at 3.49 V until the current goes down to 0.5C value or maximum 15 minutes time limit.
Discharge Procedure	Constant current discharge until 0.4 V

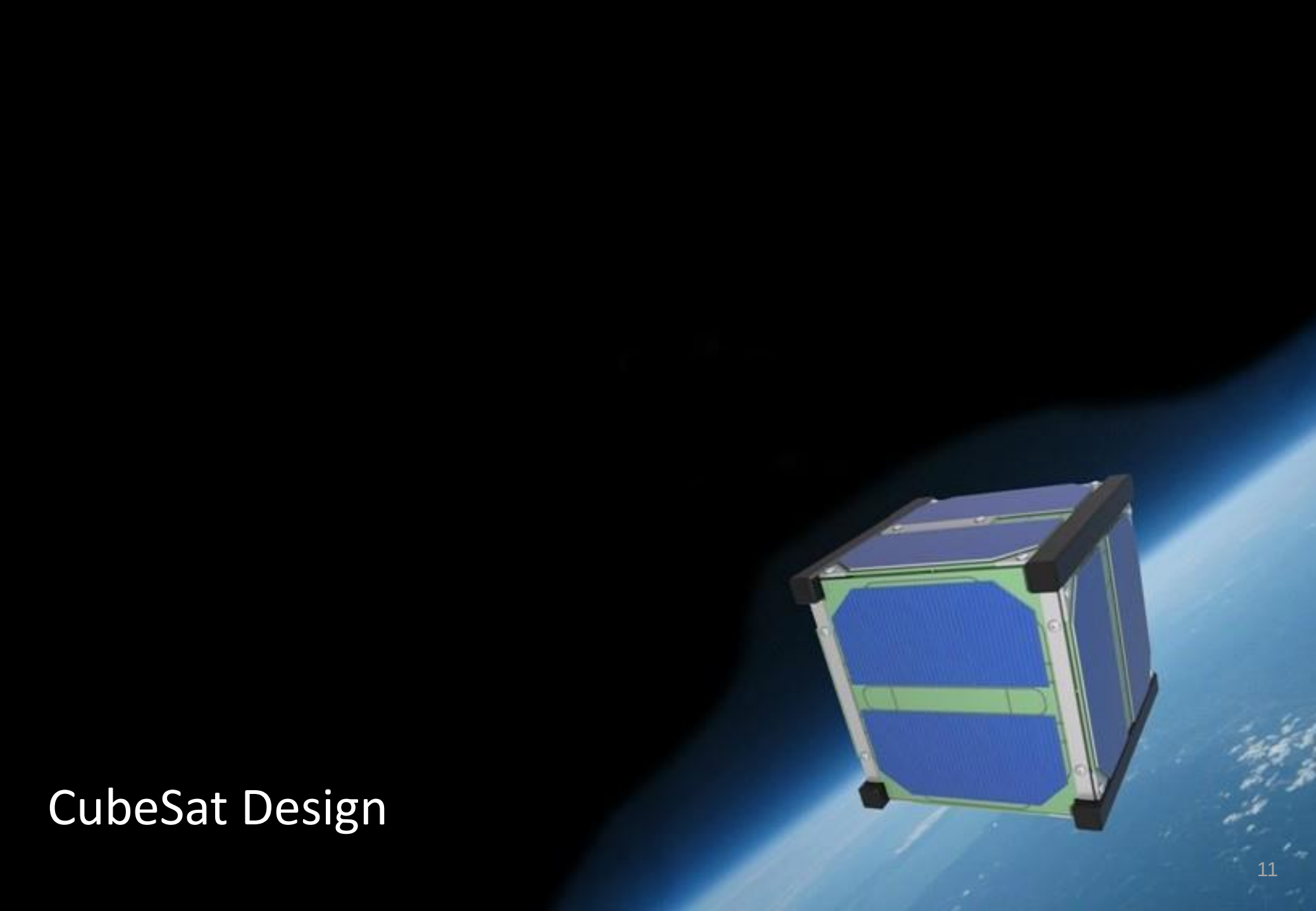
Implementation

Program Status & Team Structure

Kick-off	MCR	SRR	PDR	CDR	FMRR	PSR	Launch
12/2015	4/2016	6/2016	12/2016	6/2017	12/2017	2/2018	Q2 2018

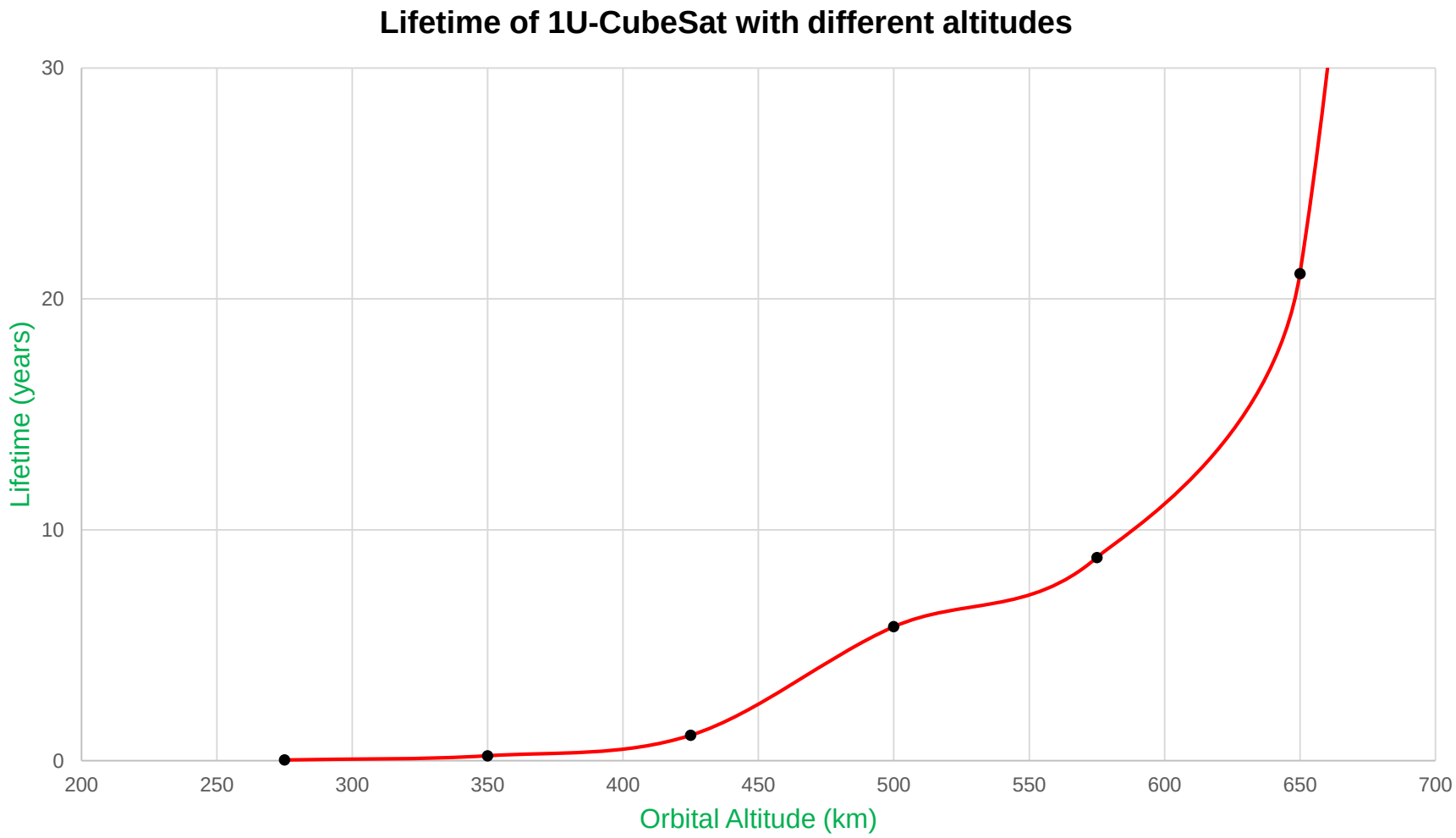


CubeSat Design



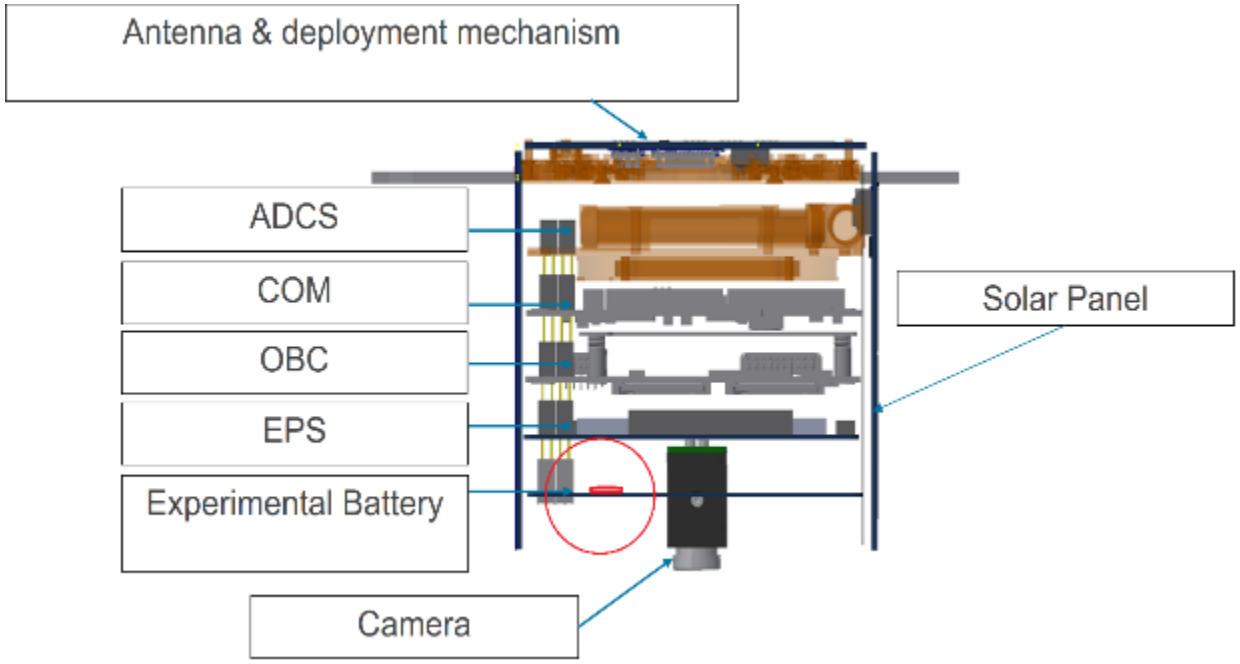
Orbit Analysis

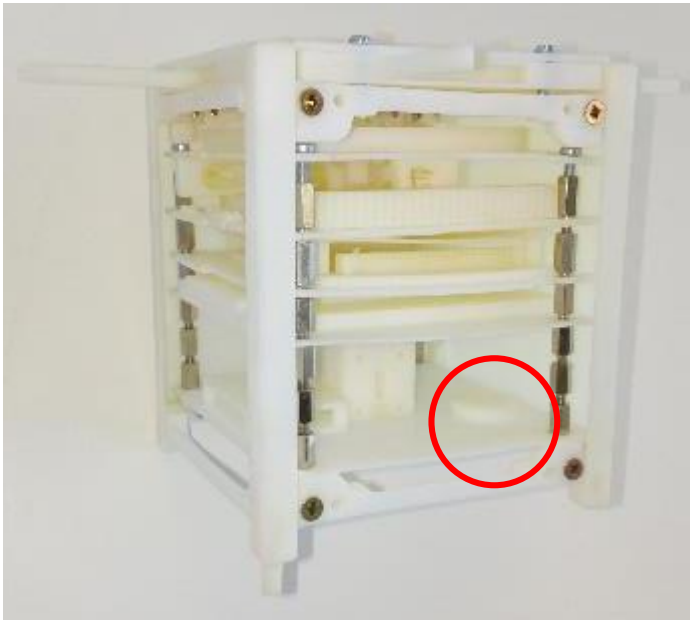
Orbital Lifetime



Orbit Analysis

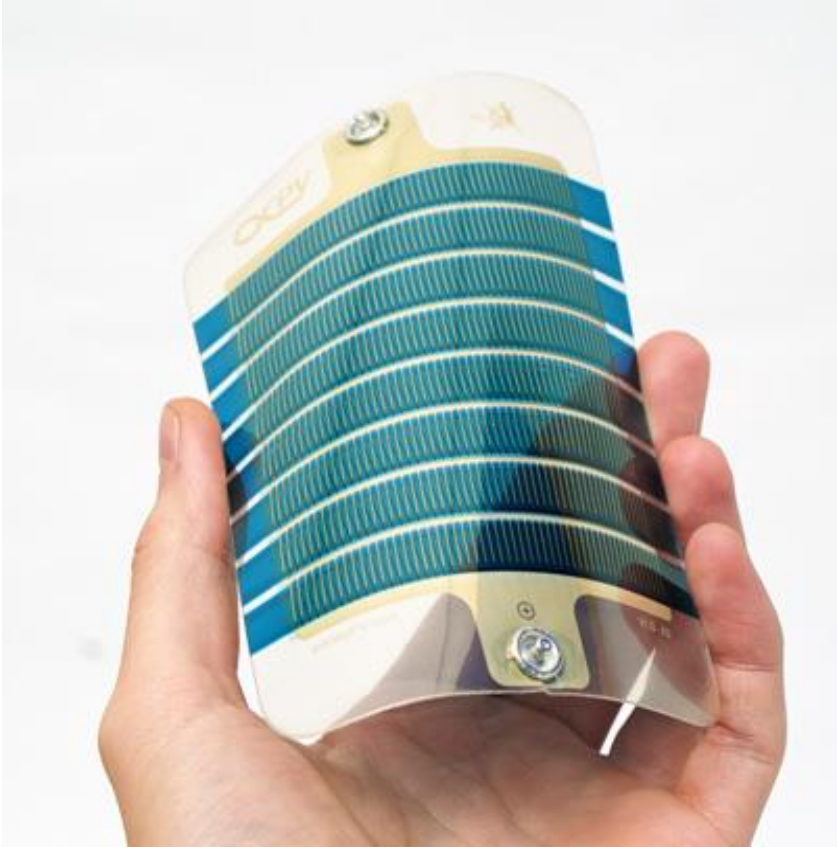
CAD view and 3D printed prototype





Other Research Activities

Developing Organic Photovoltaic Technologies for CubeSats



Organic photovoltaics (OPV): conductive polymers

Advantages:
- Low cost
- Light weight
- Flexible
- High absorption coefficients
- High throughput

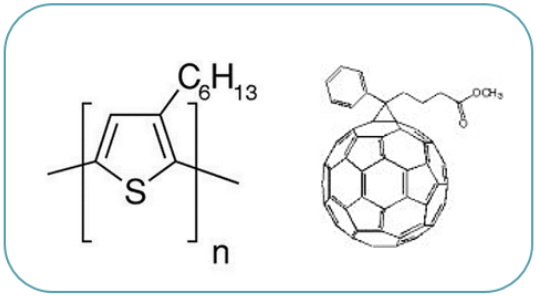
Disadvantages:
- Efficiency
- Stability
- Lifetime

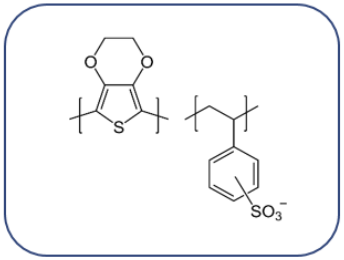
Research objectives:
Optimization of OPV at Masdar Institute
- Processing conditions
- Novel active layers
- Interlayers

Organic Photovoltaics for Space applications
- Degradation
- Temperature

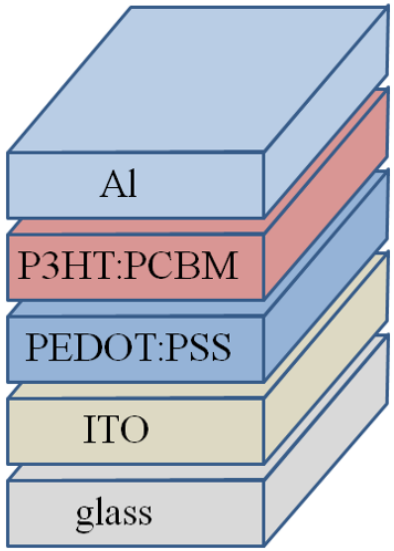
Developing Organic Photovoltaic Technologies for CubeSats

Materials molecular structure

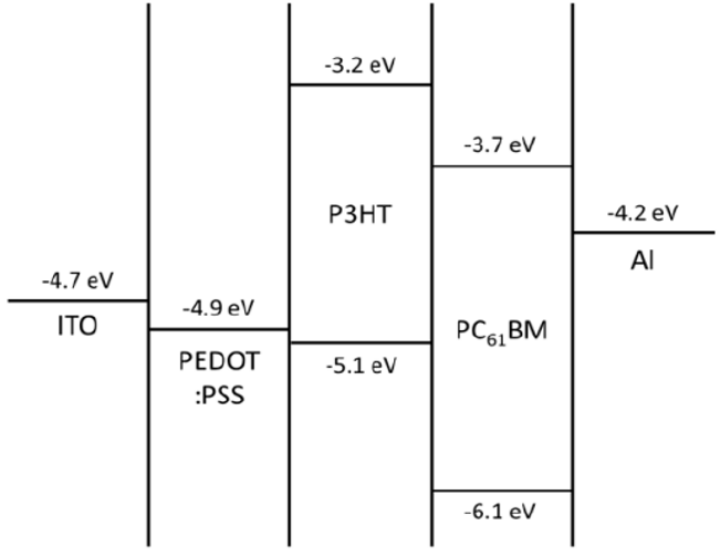




Device structure



Energy level diagram

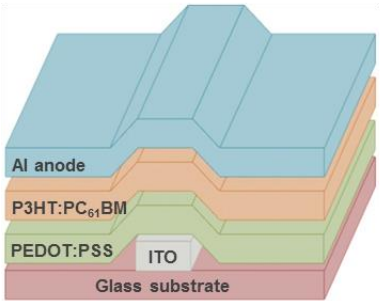


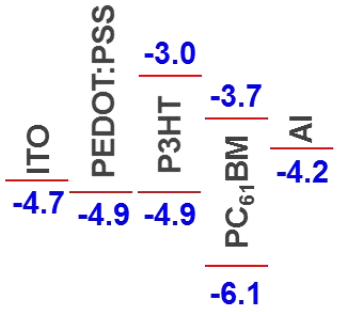
Influence of Fluorinated Additives

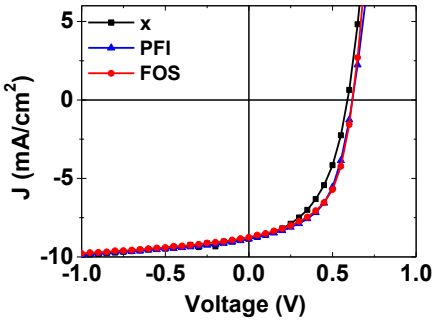
Anionic fluorinated materials (PEDOT:PSS:x):

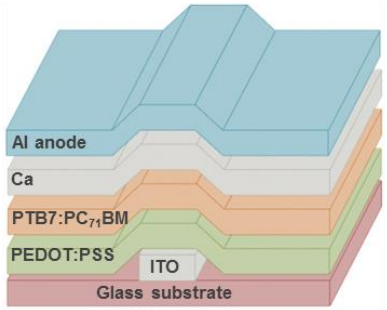
- Perfluorinated ionomer (PFI) & Perfluorooctane surfonic acid (FOS)

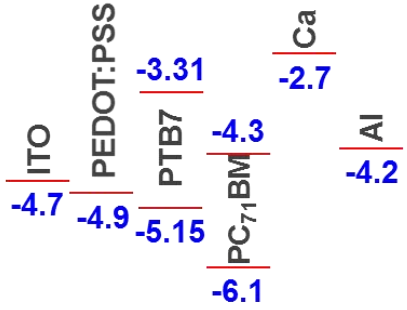
The use of PFI or FOS in P3HT:$PC_{61}BM$ improves the PCE by approximately 15 %
The PCEs for PTB7:$PC_{71}BM$ OPVs were improved by approximately 5 or 15 % with PFI or FOS, respectively

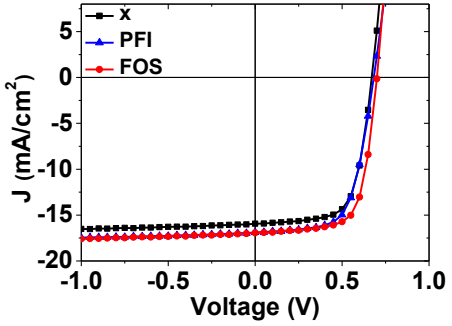










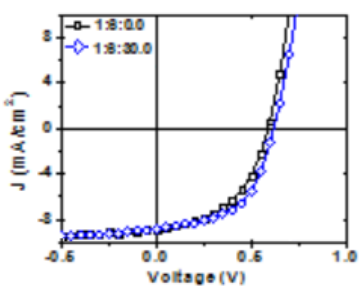


*C. T. Howells, et al. (2016). Journal of Materials Chemistry A **4**(11): 4252-4263.*

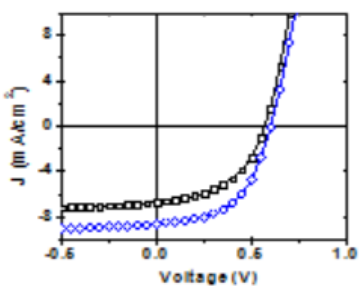
Degradation

Measurements recorded at 30 minute time intervals over 24 hours

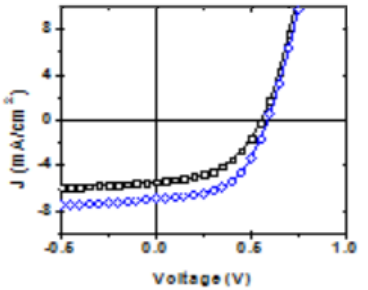
- Continuous AM1.5 G illumination at 100 mW/cm^2



t = 0 hrs



t = 0.5 hrs



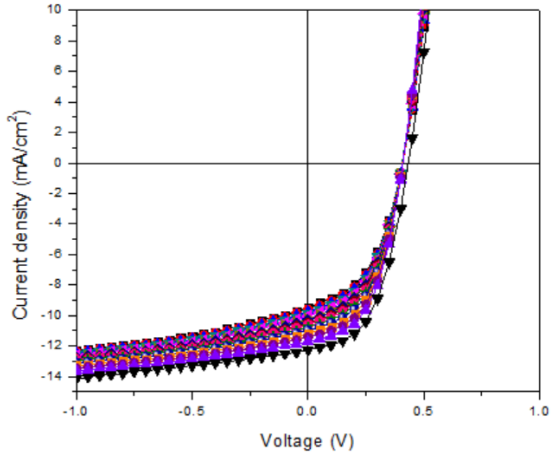
t = 24 hrs

Investigated the dynamics of OPVs containing PFI in the PEDOT:PSS

Loading (%)	Jsc (mA/cm^2)	Voc (V)x10^{-1}	FF (%)	PCE (%)
1:6:0.0 (0.00)	8.84 / 6.72 / 5.43	5.89 / 5.70 / 5.55	48.6 / 48.1 / 47.1	2.53 / 1.85 / 1.42
1:6:30.0 (81.08)	8.85 / 8.63 / 6.93	6.18 / 6.02 / 5.87	54.0 / 52.7 / 52.9	2.96 / 2.74 / 2.15

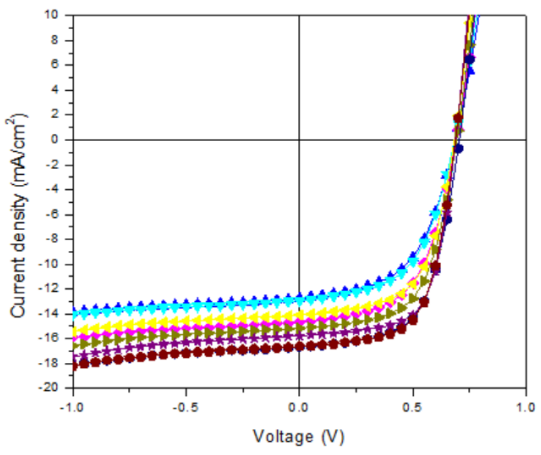
Temperature

P3HT:PCBM



Temperature (°C)	PCE (%)	Jsc (mA/cm²)	Voc (V)	FF (%)
Lo (<30)	1.794	9.463	0.4086	46.4
Lo (<30)	1.828	9.599	0.4086	46.61
-30	1.862	9.74	0.4081	46.85
-26	1.89	9.877	0.4077	46.95
-20	1.933	10.02	0.4077	47.31
-11	1.971	10.211	0.4076	47.37
-5	2.011	10.322	0.4076	47.8
-1.3	2.052	10.488	0.4077	47.98
3	2.084	10.592	0.4073	48.29
7.9	2.129	10.756	0.4067	48.65
13.4	2.184	10.95	0.4074	48.94
17.1	2.252	11.2	0.408	49.28
22	2.32	11.432	0.4088	49.65
26.4	2.415	11.72	0.409	50.32
27	2.673	12.3	0.4329	50.37

PTB7:PCBM



Temperature (°C)	PCE (%)	Jsc (mA/cm²)	Voc (V)	FF (%)
Lo (<30)	3.496	12.26	0.6951	41.02
-30	4.694	12.252	0.6911	55.44
-28	5.406	13.61	0.6988	56.84
-21	5.828	14.104	0.6851	60.31
-10	6.423	15.137	0.70423	60.25
-1.3	6.289	16.463	0.7261	52.6
5.7	6.923	15.741	0.6942	63.36
15.4	7.176	16.609	0.692	62.43

Conclusion & Future work

Conclusion

- The use of different novel active layers and interlayers was investigated in OPV , showing an enhancement in device performance.
- OPV can be possibly used for space applications. Experimental results show an enhancement in device performance, as well the lifetime and stability.

Future work

- Optimizing OPV using the advanced active layers
- Testing OPV under space environmental conditions i.e. radiation.


Thank you!