## Next generation solar cells for powering extreme habitable worlds : light-weight, flexible and printable-on-demand

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### 1. 'Print-on-demand' electronics and solar cells

During long missions in space and for specific circumstances or conditions it could be of great interest to manufacture on the spot dedicated electronics and photovoltaics through an in-flight or in-situ 'print-on-demand' procedure (cfr. '*Printable Spacecraft*'-concept of Nasa – 2012).

The functional non-conventional semi-conductor materials (e.g. conjugated polymers, hybrid perovskites, metal oxides,...) that can be used for these electro-optical devices have been improving over the last decade, leading to materials that are more stable and more resistant. Furthermore, printable electronics and solar cells can be printed on various (flexible) substrates ranging from thin plastic foils to paper, resulting in very thin (typically hundreds of nanometers) and light weight (foldable) devices.

In particular the emerging class of organic based photovoltaics – ranging from fully organic solar cells to hybrid organic-inorganic perovskite solar cells - offer a lot of potential for space applications because they are very light weight, resulting in a champion power-to-mass ratio[1], compared to other inorganic solar cell technologies (figure 1).

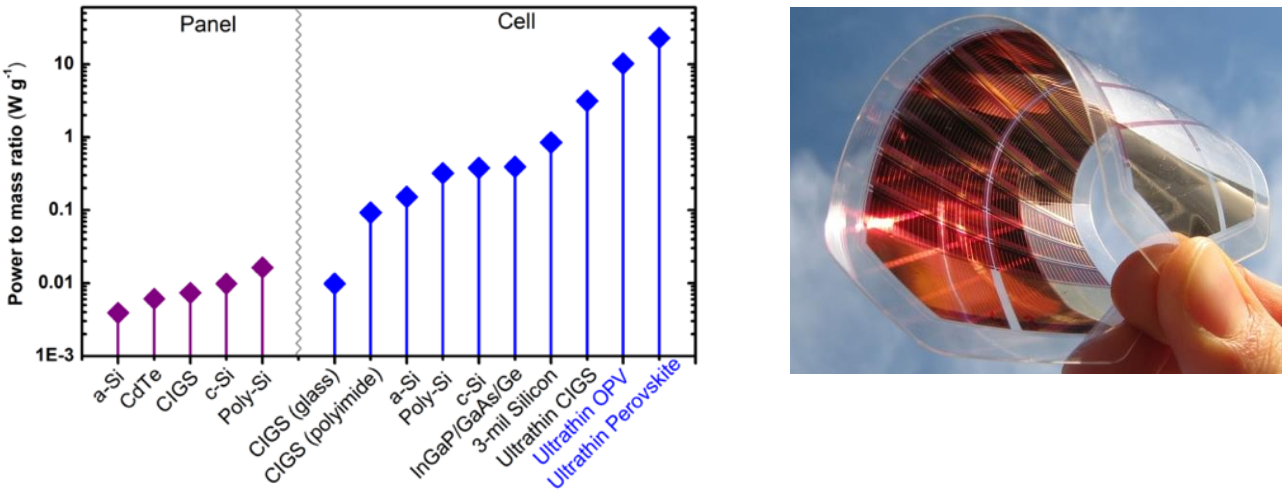


Figure 1 : Left : Power-to-mass-ratio for various types of solar cells[1-2]/ Right : Flexible organic solar cell.

Based on one hand, on arguments related to the unique combination of their intrinsic properties and versatile preparation methodology (e.g. power-to-mass-ratio in the order of 0.1-0.2 W/g for commercial devices), and on the other, on a successful first demonstration of these technologies during a near-space test mission (OSCAR-project – see below), we would like to propose organic based photovoltaics as a disruptive technology for photovoltaic energy generation in space and other extreme environments.

### 2. The OSCAR-project – first demonstration of organic based solar cells as space solar cells

The very recent OSCAR project (Optical Sensor based on CARbon-materials) aimed to explore the use of novel generation carbon based (i.e. polymer:fullerene, perovskite, diamond) optical sensors/solar cells for (aero)space applications. This has been achieved through the in-situ investigation of devices' performance during a stratospheric balloon flight in October 2016.

The concept of this experiment was to allocate organic based solar cells on modular panels, including the measurement electronics, which are mounted on the four sides of the gondola, and a centralized payload box, containing the data transmission electronics. The photovoltaic devices under test include 4 commercial polymer solar cell modules from infinityPV, 36 vacuum processed small molecule solar cells acquired from IAPP (TU Dresden), 16 polymer solar cells prepared at UHasselt, and 8 perovskite solar cells purchased from IMEC.

The launch campaign (1-10 october 2016) was very successful and the total flight time lasted more than 5 hours, including a floating phase of 2.7 hours at an altitude of 32.2 km.

Next to the in-flight experiments, in-situ climate chamber and thermal analysis experiments are ongoing to investigate the temperature window of operation and the stability for the various types of organic based solar cells.

The importance of the OSCAR-balloon experiment is that it has demonstrated for the first time the use of organic based solar cells in (aero)space conditions and it has opened the route towards future applications in extreme habitable worlds

## 3. References

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## Short Summary

During long missions in space and for specific extreme conditions it could be of great interest to manufacture on the spot dedicated electronics and photovoltaics through a ‘print-on-demand’ procedure. Organic based electronics/photovoltaics are not only printable, but also flexible, foldable and have a low weight and are therefore a potential disruptive technology for space applicatoins.