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MANUFACTURING A DEPLOYABLE SEMI-RIGID BI-MATRIX CARBON FIBRE COMPOSITE SOLAR ARRAY FOR SMALL AND NANOSATELLITES

Abstract

As the market trends towards miniaturized satellites, on-board space becomes more limited while their applications become ever more energy-intensive. Conventional body mounted and hinged solar arrays are not adapted to all spacecraft, neither is their energy generation always sufficient, hence the need of numerous new high-power applications for more innovative deployable solar arrays.

The ESA-funded Power Cube project was launched in 2021 with this in mind, in which DcubeD (Deployables Cubed GmbH), German Orbital Systems GmbH, AzurSpace GmbH and Deggendorf Institute of Technology teamed up to develop a new generation of compact, deployable solar arrays. "Power Cube" only occupies a stowed volume of 1U, but is capable of generating 100W once deployed, thanks to an origami-style folding pattern which maximizes its deployed, energy-generating area to stowed volume ratio. The full qualification campaign will take place in June 2022, while the maiden flight is planned for 2023 aboard "PowerSat", a 3U satellite developed and manufactured by California Polytechnic State University, through the NASA ElaNA initiative.

At the heart of this paper and forming the frame of the array is the composite substrate. Made from a single continuous carbon fibre reinforced plate, its defining characteristic is a bi-matrix system, containing distinct silicon and epoxy parts. The silicon is used to create a network of flexible hinges forming the origami folding pattern, the epoxy to create the semi-rigid panels onto which the fragile solar cells are mounted. The resulting structure must simultaneously be flexible enough to be tightly folded, store sufficient energy so as to deploy independently when triggered by a release actuator and yet remain stiff enough to maintain its shape in the deployed state without external support or pre-loading. Its creation poses a huge technical challenge as the two different materials must be incorporated into a single part. Furthermore, the hinge network's intricate geometry must be created with high precision as a

folding pattern defect could prevent the array not only from folding but also from fitting into the imposed volume.

This paper will offer a brief overview of the design of the array, then delve deeper into how the PowerCube team went about developing the bi-matrix structure. The choice of materials, the pre-manufacturing tests, the manufacturing method and its subsequent optimizations will be covered. A presentation of the functional and deployment tests carried out on the substrate, up to the integration of the solar cells, will wrap up this paper.