

## Design and fabrication of a mesh reinforced membrane inflatable deployable reflector and its shape stability

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### Abstract

Maintaining shape accuracy of reflector is the key point of deployable antennas. Several applications may give us ideas to design an inflatable reflector with high shape accuracy. Such as carbon-reinforced isogrid inflatable booms[1], pumpkin balloons[2], mesh reinforced membrane (MRM) inflated beam[3]. Inspired by MRM, a mesh reinforced membrane inflatable deployable reflector was proposed. It mainly includes membrane reflector, mirror reflector, reinforced mesh and edge ring, among which the membrane reflector is the main functional layer; the reinforced mesh is designed to improve the shape stability of reflector and can be optimized to meet different performance requirements.

A MRM inflatable deployable reflector (focal length to diameter ratio  $F/D=0.8$ , Diameter=3.0m) was designed and fabricated. The fabrication process was shown in Figure 1. The shape accuracy testing of membrane reflector was conducted by the Video-Simultaneous Triangulation and Resection System (V-STARS). RMS value of the geometric configuration between the fabricated membrane reflector and designed membrane reflector was used to evaluate the shape accuracy. As shown in Figure 2, the results revealed that the MRM reflector performed higher shape accuracy than the pure membrane reflector.

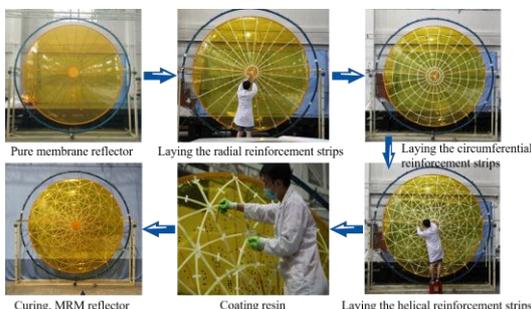


Fig.1 The fabrication process of MRM reflector

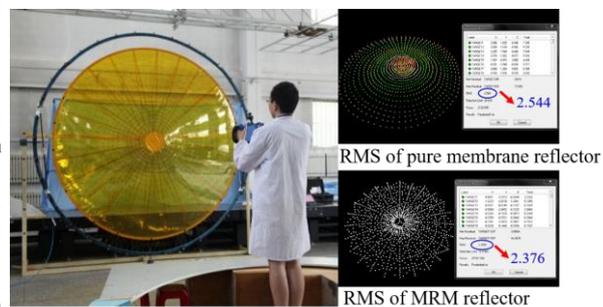


Fig.2 The shape accuracy testing of MRM reflector

Also, the characteristics of the pressure expansion and the deformability against the external load were studied via the numerical simulations. The results showed that the reinforced mesh greatly improved the shape stability of the inflatable membrane structure. What is worth mentioning was that resin used in the fabrication process was shape memory polymer in order to enable the MRM reflector folding and deployable.

### References

- [1] R. E. Allred, A. E. Hoyt. "UV Rigidizable Carbon-Reinforced Isogrid Inflatable Booms", *AIAA Journal*, vol. 1202, pp.1-11, 2002.
- [2] M. Pagitz, S. Pellegrino. "Buckling pressure of pumpkin balloons", *International Journal of Solids and Structures*, vol. 44, pp. 6963-6986, 2007.
- [3] Q. Tao, C. G. Wang, Z. M. Xue, Z. M. Xie, H. F. Tan. "Wrinkling and collapse of mesh reinforced membrane inflated beam under bending", *Acta Astronautica*. vol.128, pp. 551-559, 2016.