SATELLITE PAYLOAD AND LAUNCH APPLICATIONS

WHITE PAPER

CHOOSING THE BEST REINFORCEMENT

'TORAY'

Toray Advanced Composites

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Choosing the Best Reinforcement

INTRODUCTION

Defining the "best" reinforcement for any application should start at the macroscopic (system) level, ensuring parameter optimization for each key attribute of the system. Nearly every customer reviews the following when making purchase decisions:

- Affordability (highest value at minimum cost)
- Heritage/design database (what is the company and product history)
- Structural suitability and efficiency for the application (including moisture/fluid resistance and hot-wet properties)
- Product forms, resins available, and compatibility with the reinforcement
- Manufacturability and inspectability (including specific capabilities an individual customer may possess, i.e., OOA may be required if no autoclave is available or AFP/ATL to minimize labor costs may be mandated)

In addition to the above considerations, when it comes to satellite payload and launch applications, it's imperative to drill down deeper to ensure the ideal material choice.

FIBER CHOICE

Narrowing the selection further depends on the specifics of the application. Satellite payloads are unique, requiring materials with very high specific stiffness and strength. They must be able to survive aggressive thermal cycling and resistance to microcracking, thermal conductivity, low outgassing, and radiation resistance. Except for the two latter properties, fiber choice is a dominant or strong contributing factor in the decision. Payloads have strongly favored HM and UHM PAN carbon fibers from a variety of suppliers (predominantly Toray, with Hexcel and Toho-Teijin being significant contributors) with some UHM pitch used (mainly from NGF and Mitsubishi). Additionally, choosing a specific fiber (and resin) depends on what type of structure will be built from the composite: busses, reflectors, solar array substrates, optical benches, and booms/tubes/trusses.

DOWNSELECTION CONSIDERATIONS

Reinforcement (and resin) requirements for launcher structures are very similar to those for aircraft structures. These are distinct from payloads in their general need for resistance to impacts (CAI) and ability to join structures via mechanical fasteners (OHC/FHC, OHT/FHT). Other key factors when considering launcher structures include the final part size and the time required to build up the composite structure. Out life and tool life are primary here, as are resin defined properties, so they must be considered along with the fiber choice to ensure success.

REINFORCEMENT TYPE

Whether to use a fabric or a uni-directional tape for either payloads or launchers usually boils down to two considerations: the cost associated with building up the composite structure and structural efficiency. These are often primary trades in the basic material selection. Again, launchers tend to be somewhat different from satellite payloads in that there is a desire to build up the composite structure as quickly as possible, minimizing touch labor and maximizing lay-down rate and speed of ply build-up.

There is a small trade involved, however. For the same weight of a composite placed in a structure, fabrics are generally marginally more expensive, but generally can be applied at least twice the rate of a uni-directional tape. When structures are constructed with a high manual labor content, the cost of fabric is often greatly overshadowed by the savings in labor. If ATL or AFP machinery is available, most often, the lower cost per weight of uni-directional prepreg provides a significantly larger benefit versus a fabric option.

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