

Material Efficiency – A first step toward sustainable manufacturing

Summary

A major paradigm shift is occurring in the manufacture of commercial aircraft, in which metallic structures are being replaced by composite designs. Composite structures offer advantages over metallic parts, such as weight reduction, superior resistance to fatigue and corrosion, and reduced maintenance. Presently, composite manufacturing for aerospace involves automated lay-up of prepreg plies, followed by compaction and cure in an autoclave. Autoclave processing is energy intensive and costly. This presents a problem, because the demand for air travel is increasing, and production rates will need to increase by a factor of 4 to meet projected demand. This is not economically feasible using autoclaves, so sustainable out-of-autoclave (OOA) manufacturing methods are required to exploit the advantages of composite materials.

Moving composite processing out of the autoclave will reduce production costs and energy demands. While traditional autoclave processing involves high pressures that effectively suppress formation of strength-limiting porosity, most OOA methods involve low pressures. For example, a new generation of OOA prepreps has been formulated for compaction with simple vacuum bags, which involve low pressure. These vacuum-bag-only (VBO) materials have the potential to greatly reduce production costs, while improving material and manufacturing efficiency. However, before VBO methods can be safely used, a clear scientific understanding of the effects of process parameters on strength-limiting defects is required. Our goal is to develop this understanding for VBO-OOA manufacturing.

Development of sustainable OOA manufacturing methods will enable increased use of composites in the aerospace industry, increased aircraft fuel efficiency, and reduced emissions. Expanding the use of innovative OOA methods will reduce energy consumption during manufacture as well. Optimizing each step of the manufacturing process, from lay-up to final cure, will achieve significant savings in material, equipment, and energy.