National Aeronautics and
Space Administration

TECHNOLOGY SOLUTION

Manufacturing

AERoBOND: Large-scale Composite Manufacturing

A method for the reliable manufacturing of complex composite structures

NASA Langley Research Center has an improved method for making composite structures. Industrial composite manufacturing is primarily accomplished through three methods: co-cure, co-bond, and secondary bond processes. Co-cure produces predictable structures and joint properties but is costly and challenging to implement on large, complex structures. Co-bond and secondary bond processes have greater applicability to complex structures but produce unpredictable material interfaces and properties. NASA's AERoBOND technology presents a method for manufacturing composites at scale with the reliability of co-cure in a 'bonded' assembly process. AERoBOND utilizes novel epoxy and barrier ply layers with optimized chemical and physical properties to enable the bonding of large, complex composites with the advantages of co-cure assembly but without the need for redundant fasteners, thus reducing assembly time and cost.

BENEFITS

- High Throughput: up to 40% faster than state-of-the-art composite manufacturing method
- Scalability: precursor materials are commercially available, and the process is readily scalable
- Reliability: eliminates the potential for weak bond failure modes that can occur in bonded assemblies
- Excellent Mechanical Properties: composites produced via AERoBOND have mechanical performance that is comparable with co-cure or co-bond equivalents

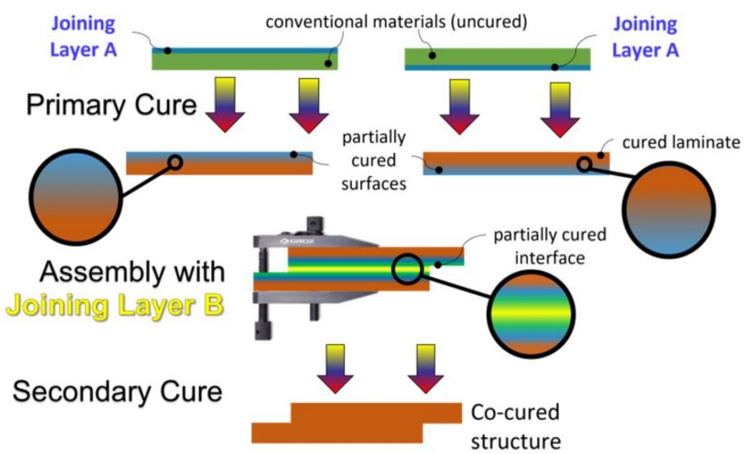
APPLICATIONS

The technology has several potential applications:

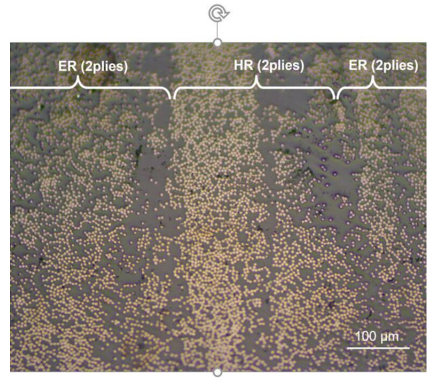
- Aerospace: composite airframe and fuselage assembly for ultra-efficient aircraft structures
- Marine: lightweight, damage-resistant hulls
- Wind Energy: wind turbine blades
- Automotive: fuel-efficient framing and parts
- Architecture: structural building components

THE TECHNOLOGY

This technology (AERoBOND) enables the assembly of large-scale, complex composite structures while maintaining predictable mechanical and material properties. It does so by using a novel barrier-ply technology consisting of an epoxy resin/prepreg material with optimal efficiency, reliability, and performance. The barrier-ply materials prevent excessive mixing between conventional composite precursors and stoichiometrically-offset epoxy precursors during the cure process by forming a gel early in the cure cycle before extensive mixing can occur. The barrier ply is placed between the conventional laminate preform and the stoichiometrically-offset ply or plies placed on the preform surface, thus preventing excessive mass transfer between the three layers during the cure process. In practice, the barrier ply could be combined with the offset ply to be applied as a single, multifunctional surfacing layer enabling unitized assembly of large and complex structures. The AERoBOND method is up to 40% faster than state-of-the-art composite manufacturing methods, allows for large-scale processing of complex structures, eliminates the potential for weak bond failure modes, and produces composites with comparable mechanical properties as compared with those prepared by co-cure.



Schematic illustration of the AERoBOND co-cure and assembly process.



Micrograph of bonded composite assembly demonstrating high quality interfaces. No interfaces are visible between the epoxy rich and hardener rich layers in the micrograph indicating that intimate contact and healing occurred prior to gelation and cure.

PUBLICATIONS

Patent No: 10,369,767; 10,549,516

Patent Pending

(1) Palmieri, F.L., Hudson, et.al., Latent cure epoxy resins for reliable joints in secondary-bonded composite structures. Composites Part B: Engineering, 231, 109603 (2022). (2) Palmieri, F. L., Hudson, et. al., NASA Facts: AERoBOND Project. TACP Showcase. (2021). (3) Palmieri, F. L., & Hudson, T. B. AERoBOND Project Summary. (2020). (4) Palmieri, F.L., Hudson, et. al., Reduced Dependence on Redundant Fasteners in Secondary-Bonded Composite Structures Using Modified Epoxy Matrix Resins. 43rd Ann. Mtg of The Adhesion Society. No. NF1676L-34246. Feb.2020).

More Information

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