Novel Bonding Methodologies Toward the Attainment of Primary Bonded Aircraft Structure

Dr. John W. Connell, Advanced Materials and Processing Branch, NASA LaRC
Dr. Christopher J. Wohl, Advanced Materials and Processing Branch, NASA LaRC
Dr. Frank L. Palmieri, National Institute of Aerospace (NIA)
Mr. John W. Hopkins, Fabrication Technology Development Branch, NASA LaRC
Dr. Kay Y. Blohowiak, The Boeing Company
Dr. Marcus A. Belcher, The Boeing Company

ABSTRACT

Adhesive bonding offers many advantages over mechanical fastening, but requires certification before it can be incorporated in primary structures for commercial aviation without disbond-arrestment features or redundant load paths. Surface preparation is widely recognized as the key step to producing robust and predictable bonds. Laser ablation imparts both topographical and chemical changes to a surface which can lead to increased bond durability. A laser based process provides an alternative to chemical-dip, manual abrasion and grit blast treatments which are expensive, hazardous, polluting, and less precise. This report documents preliminary testing of a surface preparation technique using laser ablation as a replacement for the chemical etch and abrasive processes currently applied to Ti-6Al-4V alloy adherends. Failure mode, surface roughness, and chemical makeup were analyzed using fluorescence enhanced visualization, microscopy, and X-ray photoelectron spectroscopy, respectively. Single lap shear tests were conducted on bonded and aged specimens to observe bond strength retention and failure mode. Some promising results showed increasing strength and durability of lap shear specimens as laser ablation coverage area and beam intensity increased. Chemical analyses showed trends for surface chemical species which correlated with improved bond strength and durability. Combined, these results suggest that laser ablation is a viable process for inclusion with or/and replacement of one or more currently used titanium surface treatments. On-going work will focus on additional mechanical tests to further demonstrate improved bond durability.