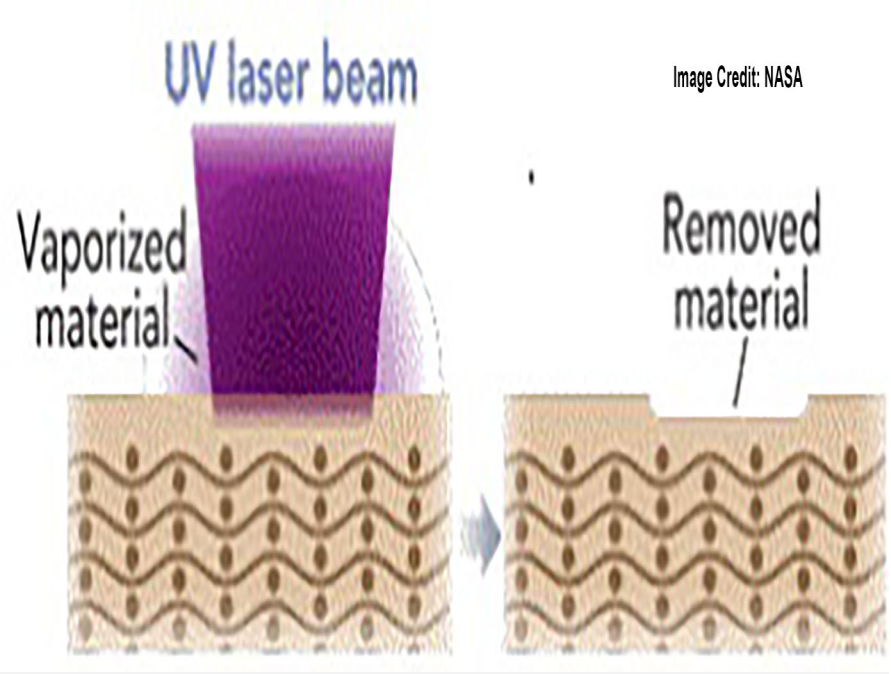


Image Credit: NASA

National Aeronautics and Space Administration

Robotics, Automation and Control

Laser Surface Treatment and Spectroscopic Analysis System

Improved analysis of CRFP surfaces combined with cleaning needed for more reliable adhesive bonding for light weight aircraft and spacecraft

In the aerospace industry, the use of carbon fiber reinforced polymers (CFRP) has enabled significant weight and fuel savings, leading to more economical and environmentally friendly large transport aircraft. To further advance aircraft performance and/or reduce manufacturing costs, there is a desire to replace mechanical fasteners with adhesive bonds. Presently, for primary structures on commercial transport aircraft to meet certification criteria designated by the FAA, adhesively bonded assemblies often rely on arrest features to prevent catastrophic failures. Adhesive bonding is used in secondary aircraft structures and has demonstrated excellent reliability. In cases where failures have occurred, the cause is often traced back to improper materials and process controls. Such process controls involve surface treatment and verification to ensure that the surface has been chemically activated and is free of contaminants, which may cause inadequate bonding.

BENEFITS

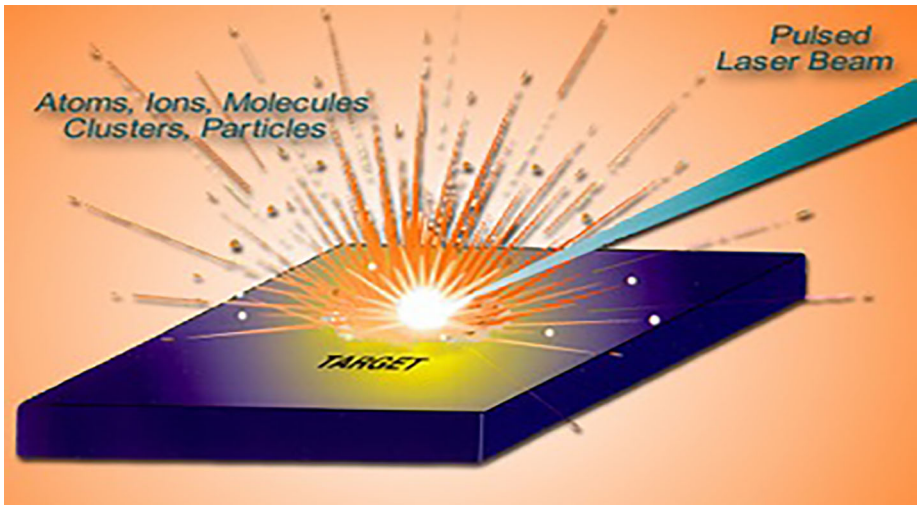
- Integrates the surface treatment process with surface chemical analysis
- Detect silicone levels below that are known to be a threat to adhesive bonding
- Operates under ambient conditions and no sample preparation required
- Provide a characterization process that is nearly non-destructive
- Deliver rapid analysis and feedback of results
- Detect multiple elements
- Is automatable, reproducible, reliable, traceable, amenable to standardization

technology solution

THE TECHNOLOGY

This invention consists of an integrated laser/spectroscopic analysis system in which the laser is used for the surface treatment of a variety of substrates to remove contaminants and create topography and/or chemically reactive species. The laser also serves as a means to excite the surface to allow for spectroscopic analysis and characterization of chemical and elemental species that emanate from that surface, thus giving an indication of the effectiveness of the removal of contaminants by the laser surface treatment. The technology works under ambient environmental conditions, requires no sample preparation, provides near real time feedback on surface composition and can detect levels of contaminants below those known to be a threat to adhesive bonding.

The instrument is designed to measure low levels of surface contamination on surfaces with various construction, contours, and shapes. The information provided will improve analysis of surface preparation needed for more reliable adhesive bonding, a technique that is becoming more important in lighter weight (and hence more fuel efficient) aircraft and spacecraft. A major factor in adhesive bond durability is contamination left behind by surface preparation techniques. It has been shown that contamination species and concentration levels are major contributors to adhesive bond failures. Such surface treatment is critical in the assembly of major structures such as Boeings new 787 Dreamliner which is made almost exclusively of carbon fiber composites.



Exposing a surface to a laser beam ablates particles that can be analyzed spectroscopically.
Image Credit: NASA

APPLICATIONS

The technology has several potential applications:

- Joining of functional structures made from carbon fiber composites (CFRP's) where the strength of adhesive joining is critical
- Mold cleaning
- Oxide removal
- Surface cleaning
- Baking tray cleaning
- Removal of coatings and release agents
- Removal of oil and grease
- Gluing pre-treatment
- Tool cleaning

PUBLICATIONS

Patent No: 10,677,741

More Information

National Aeronautics and Space Administration

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