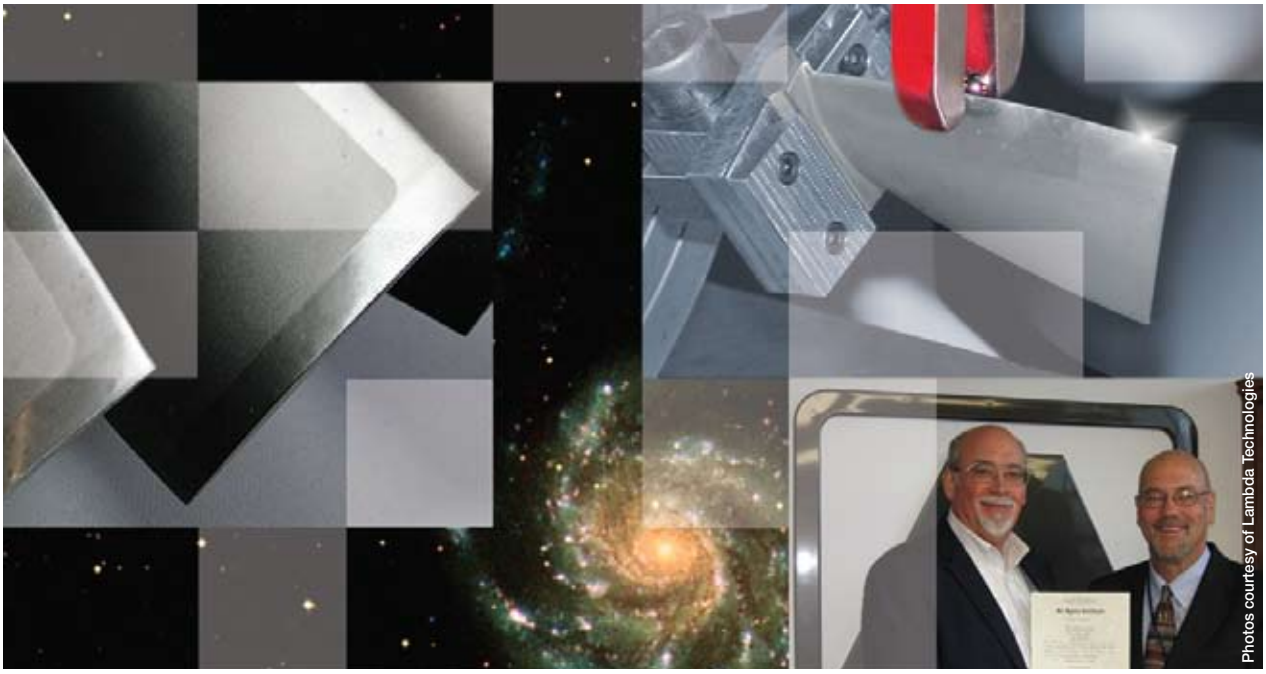
National Aeronautics and Space Administration

SBIR Company Creates Low-Cost Method for Increasing Metal Component Durability and Life Span



Clockwise from left: *IBR post processing, turbine engine blade during processing, Paul S. Prevéy III (left) receiving Lambda's FAA 145 license*

Lambda Research Inc. (now part of the Lambda Technologies group) received Small Business Innovation Research (SBIR) funding from NASA's Glenn Research Center to apply and demonstrate its low plasticity burnishing (LPB™) method to significantly increase the durability and life span of metal components. This quick, convenient, and affordable process produces beneficial surface compressive residual stresses. The resulting compressive residual stresses extend much deeper than shot peening, providing much greater damage tolerance and crack resistance than other methods, which are more expensive, deform the material excessively in an effort to strengthen it, and/or must be done in a dedicated facility.

Lambda spun-off Surface Enhancement Technologies, LLC (SET), forming the Lambda Technologies group to license, market, and provide LPB services. Currently, the U.S. Navy, U.S. Air Force, Delta Airlines, Idaho National Laboratory, and orthopedic equipment manufacturers all use the LPB process.

LPB is a trademark of Lambda Technologies.

Benefits of Technology Transfer

- **Effective:** Provides greater depth and stability of the compressive layer, compared with other surface treatments, like shot peening
- **Inexpensive:** Processes a single component for one-tenth the cost of laser shock peening
- **Cost effective:** Uses existing machining equipment that allows on-site work
- **Robust:** Improves resistance to fatigue, damage, and crack growth, reducing maintenance costs over the life of assembled system
- **FAA-accepted:** Has an FAA 145 license (2009) that allows use for the repair and modification of aircraft components
- **Bio-versatile:** Eliminates fatigue failure from the neck segments of modular total hip prostheses

success

On the Record

"Working with NASA, particularly during the initial demonstration phases for applying LPB to nickel-based alloys, has been extremely valuable in that it provided visibility for this technology in aircraft and aerospace-related forums. NASA's support of LPB through its Web site has continued to encourage inquiries from industry, which have led to further commercialization." — *Paul S. Prevéy III, Lambda Technologies CEO and Director of Research*

"The NASA SBIR program provided an ideal opportunity to work with Lambda Technologies on their new, highly innovative process." — *Tim Gabb, Metallurgist, NASA's Glenn Research Center*

About Lambda Technologies

Lambda Technologies of Cincinnati, Ohio develops and optimizes surface treatments to solve fatigue and stress corrosion problems in titanium, aluminum, and nickel-based alloy and steel components.

About the Technology

Not long after receiving its first patent in 1996, Lambda applied for and received an SBIR contract from Glenn to study using the technique as a low-cost enhancement method for improving the fatigue life of superalloys. Superalloy disks are used to hold the compressor and turbine blades in aerospace gas turbine engines. To prevent surface fatigue cracks, the disks usually are shot peened to plastically deform their surfaces, producing beneficial compressive residual stresses. For advanced turbine engines to operate most efficiently, temperatures need to reach 650-700˚C, causing the residual compression from shot peening to relax, eliminating the effectiveness of the treatment.

The LPB process differs from shot peening, conventional ball or roller burnishing, also known as "deep rolling," using the minimal amount of plastic deformation (or "cold working") needed to create the level of residual stress required to improve fatigue or stress corrosion performance. Low cold working provides both thermal and mechanical stability of the beneficial compression. LPB uses a patented constant volume hydrostatic tool design to "float" the burnishing ball continuously during operation, regardless of the force applied. This provides extended tool life and eliminates the possibility of dragging the ball and damaging the surface.

Although laser peening can achieve similar results, LPB can be used for approximately 10 percent of the cost and can be performed in the manufacturing facility with existing CNC machine tools or robotic equipment. Furthermore, no known environmental, safety, or other hazards are associated with LPB beyond those encountered with routine machine tool operation. Moreover, the LPB process can be applied during initial manufacturing, maintenance and repair operations, or in-situ.

The Transfer Process

The three-phase SBIR program reserves a specific percentage of federal R&D funding for awards to small businesses, to move ideas from the laboratory to the marketplace, foster high-tech economic development, and address the technological needs of the federal government. Lambda furthered applications for its technology under Phase I and Phase II SBIR contracts from Glenn. It also has received eight additional SBIR contracts from other government agencies including the U.S. Navy, U.S. Air Force, U.S. Department of Energy, and U.S. Army, extending applications from aircraft engines and structures to nuclear welds and artillery.

Commercial Successes

The company has successfully commercialized the LPB process for aviation safety and biomedical uses. In April 2009, Lambda Technologies announced an exclusive partnering agreement with Delta Airlines to use LPB for the surface enhancement of commercial aircraft components. Lambda Technologies' SET also has processed 5,500 engine vanes that are now flying for the U.S. Navy's Harrier F402 engine, eliminating a fatigue-critical, foreign object damage sensitivity.

Lambda Technologies has a licensing agreement with Exactech, a Gainesville, Florida orthopedic implant maker. The company uses LPB to eliminate fretting-induced metal fatigue from the neck segments of modular total hip prostheses (THP). Modular THP give surgeons more flexibility in treating a wide spectrum of hip defects, but fretting can occur at the tapered connection points. Laser peening was eliminated as an option because of cost and processing time. Another method was abandoned because of lack of control during application and minimal fatigue strength improvement. LPB successfully eliminated fretting at the neck taper and increased fatigue strength by 40 percent.

For More Information

For more information about Glenn's technology transfer opportunities, please visit:

Technology Transfer and Partnership Office
NASA's Glenn Research Center
E-mail: ttp@grc.nasa.gov
Phone: 216-433-3484
http://technology.grc.nasa.gov/