Surface Treatment Technologies, Inc.
1600 Wicomico Street, Baltimore, MD 21230
(410) 332-0633 http://www.stt-inc.com

Laser Induced Surface Improvement and Electro-Spark Alloying

DESCRIPTION OF THE TECHNOLOGY

With support from the Environmental Protection Agency's (EPA) Small Business Innovation Research (SBIR) Program, Surface Treatment Technologies, Inc. (ST2) adapted two novel methods of applying coatings for the protection of metal surfaces from wear and corrosion to address the issue of hard chrome replacement. Invented and patented by the University of Tennessee Space Institute, Laser Induced Surface Improvement (LISI[SM]) uses patented laser beam optics to produce an alloy of the substrate on the surface. Electro-Spark Alloying (ESA) is a micro-welding process by which coatings are applied in short pulses from an electrode to deposit nano-grained microstructure coatings to metal substrates. Both coating processes are distinctive in their ability to provide an engineered surface that is metallurgically bonded to the substrate material, thereby giving them a clear advantage in adhering to the substrate when compared with traditional coating methods.

The LISI[SM] process has been applied primarily to steel and aluminum substrates to protect from wear and corrosion. The process is carried out by first spraying the substrate with a "paint" of metal powders composed of the alloying elements to be melted into the surface. The key to LISI[SM] is the beam geometry that then passes over the sprayed area in adjacent lines, creating an instantaneous melt pool to create the desired alloy mix with the substrate and precursor alloy powder. The resulting surface is a uniform layer roughly 500 microns thick of the new surface alloy metallurgically bonded to the substrate.

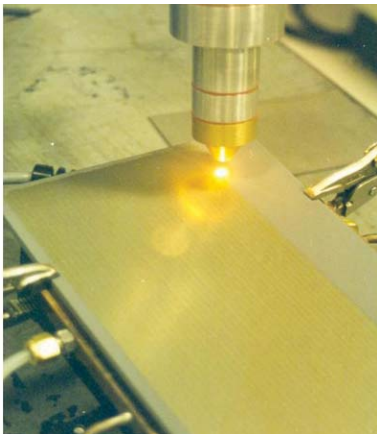
ESA is a micro-welding process in which the deposition of material from electrode to the substrate is controlled by computer to form a very uniform, complex coating chemistry without inducing heat into the substrate metal being coated. The consumable electrode is brought into direct contact with the part being coated, and an onboard computer controls the deposition of the coating, offering the following unique capabilities: (1) a full metallurgical bond between the electrode coating and the substrate metal; (2) no heat affected zone in the base alloy; (3) an amorphous to nano-grained structure in the coating; (4) the ability to coat very small internal diameters, down to 0.2 inches; and (5) the ability to coat non-line-of-sight areas. Moreover, the ESA process can be readily coupled to multi-axis tooling to become a highly reproducible manufacturing process.

SIGNIFICANCE OF THE TECHNOLOGY

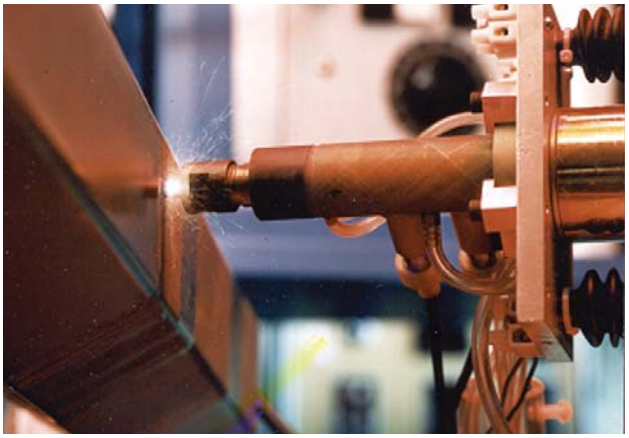
Both LISI[SM] and ESA are environmentally friendly procedures. Applications of LISI[SM] range from wear surfaces

SBIR Impact

- **ST2 adapted two novel and environmentally friendly methods of applying coatings for the protection of metal surfaces from wear and corrosion.**
- **LISI[SM] uses patented laser beam optics to produce an alloy of the substrate on the surface. ESA is a micro-welding process in which the deposition of material from electrode to the substrate is controlled by computer to form a very uniform, complex coating chemistry without inducing heat into the substrate metal being coated.**
- **Both LISI[SM] and ESA are distinctive in their ability to provide an engineered surface that is metallurgically bonded to the substrate material, thereby giving them a clear advantage in adhering to the substrate when compared with traditional coating methods.**
- **Applications of LISI[SM] range from wear surfaces for aluminum engine cylinders to replacing chrome plating in large-caliber gun barrels.**



LISI[SM] uses patented laser beam optics to produce an alloy of the substrate on the surface.



ESA is a micro-welding process by which coatings are applied in short pulses from an electrode to deposit nano-grained microstructure coatings to metal substrates.

for aluminum engine cylinders to replacing chrome plating in large-caliber gun barrels. LISI[SM]:

- Permits precise selection of the area to be modified.
- Requires a very small amount of modifier alloy.
- Results in extremely rapid heating and cooling of the surface.
- Produces a wide variety of chemical and microstructural states outside of typical phase diagrams.
- Produces no distinct bondline; will not delaminate.
- Requires little or no surface preparation for certain applications.
- Produces a minimal hazardous waste stream.
- Can be performed remotely with robotics and fiber optics.
- Performs at rates between 20-50 ft^2/hr.

COMMERCIALIZATION SUCCESS

Under EPA funding, the ESA process has been applied to the interior bore of small arms gun barrels for the U.S. Army M249 Squad Automatic Weapon to evaluate the ability to replace chrome plating as a wear-resistant surface. A key element of this approach is the ability to coat barrel blanks prior to forging to form the rifling. Under Phase II funding, ESA was successfully used to produce full-scale barrels with five different coatings that underwent live-fire testing. Larger quantities of coated barrels were produced for longer-term live-fire evaluation by the U.S. Army. After this testing, the Army will determine if the technology should proceed into the next phases toward ultimate mass production quantites.

In a typical year, the U.S. Army purchases approximately 200,000 M249 gun barrels produced using chrome plating. Replacement of chrome plating for this application could result in a measurable reduction in the hexavalent chrome waste stream that stems from this process. If proven to be acceptable for the M249, additional reductions could be achieved through application of the ESA process for other small arms barrels.

COMPANY HISTORY

ST2 was founded in 1998 as a new source for emerging coating and surfacing technologies for metals and alloys. At present, the company offers LISI[SM], which represents an advancement in laser surface alloying, and ESA, which offers an unsurpassed combination of benefits in wear, erosion, repair, and corrosion protection for metals and alloys. ST2's goal is to innovate, develop, mature, and transition to industry advanced surface treatment technologies for wear, erosion, thermal, and corrosion protection of metals and ceramics.

What is the SBIR Program?

EPA's Small Business Innovation Research (SBIR) Program was created to assist small businesses in transforming innovative ideas into commercial products. The SBIR Program has two phases—Phase I is the feasibility study to determine the validity of the proposed concept and Phase II is the development of the technology or product proven feasible in Phase I. EPA also offers Phase II Options to accelerate the commercialization of SBIR technologies and to complete EPA's Environmental Technology Verification (ETV) Program. For more information about EPA's SBIR Program and the National Center for Environmental Research, visit http://www.epa.gov/ncer/sbir.