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High-Velocity Laser-Accelerated Deposition (HVLAD) of High-Performance Corrosion and Wear Resistance Coatings with Exceptional Interfacial Bond Strength

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High Velocity Laser Accelerated Deposition (HVLAD) is a new photonic method for producing the world's most corrosion resistant coatings, with unmatched interfacial bond strength. A high-intensity laser pulse is focused onto an advancing film-like target material, which is covered by a thin layer of water. The laser pulse generates a high-temperature plasma, and with it a very high pressure, that shears out a patch of film-like material, accelerating it to hypersonic velocities. The accelerated patch hits the substrate at an oblique angle, where the high impact velocity induces plastic flow at the film-substrate interface. This produces shear flow due to the oblique incidence, thereby resulting in the intimate mixing of target and substrate materials at the interface, with the creation of an exceptionally strong interfacial bond. An important aspect of the technique is that neither the temperature of the film material nor that of the substrate is substantially raised during the process; the process does not induce phase changes or alloy composition changes and thus allows for the strongly bonded coatings of alloys and materials that might not otherwise be possible. The strength of the "localized explosive bond" achieved with HVLAD approaches the ultimate tensile strength of the bulk material.

HVLAD enables the continuous deposition of the world's most corrosion resistant materials, including titanium and refractory metals, on a wide variety of substrates requiring protection, and can be done at ambient temperature and in open air with no special containment. For example, aluminum alloys can now be clad with corrosion-resistant titanium alloys for aerospace and marine applications. This new laser-based coating process can be used to clad inexpensive high-temperature oxide-dispersion-strengthened, or ODS, steels, which has been proposed for use in future fossil, solar and nuclear power plants, with exceptionally corrosion resistant high-temperature materials such as tantalum, thus enabling the operation of these plants at temperatures, approaching 900 degrees centigrade. HVLAD protective coatings and cladding with high-integrity interfacial bonds are capable of extending the operating temperature of energy conversion equipment, thereby achieving improvements in efficiency and extending the life of valuable equipment, thereby saving the U.S. economy tens of billions of dollars every year. For example, the annual cost of corrosion due to the deterioration of the nation's infrastructure is at least $22 billion, with the loss of another $22 billion due to the corrosion of planes, ships, vehicles and other equipment owned by the Department of Defense. New proprietary HVLAD coatings and cladding will help prevent such loss.

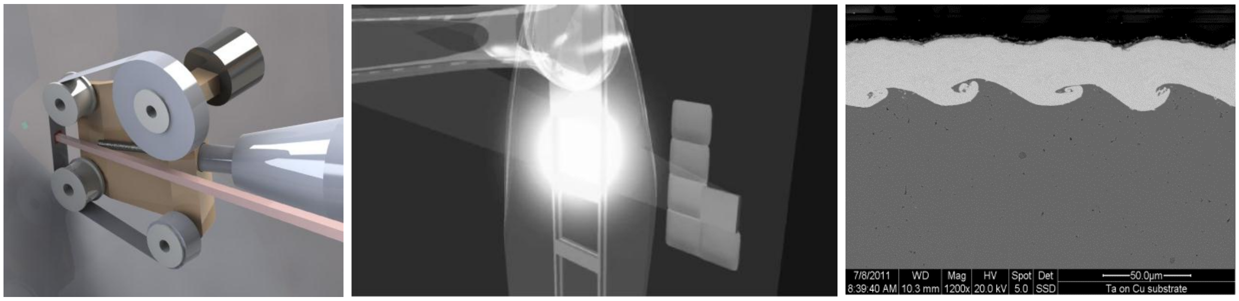

Figure 1 – HVLAD uses advanced lasers to produce high-performance corrosion and wear resistant coatings with interfacial bond strengths previously achieved only through explosive bonding.

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