Fast, Low-Temperature

Electroplating of Hard Glassy Metals

NASA seeks companies interested in licensing this coating technology for high-strength metals.

Developed at NASA Marshall Space Flight Center (MSFC), this technology is a novel method for electroplating ultra-high-strength glassy metals—nickel-phosphorous and nickel-cobalt-phosphorous—in a variety of alloys with different properties. Traditionally, these metals are deposited onto substrates via electroless deposition. NASA Marshall's technology combines the material properties associated with electroless deposition with the many process advantages afforded by electroplating. This innovative technique offers several benefits and can be used in numerous commercial applications.

Benefits

- Process is lower temperature than electroless deposition (40–65 °C vs. 85–90 °C).
- Coatings are high strength (1,930 MPa) and high hardness (50–52 on Rockwell C scale).
- Residual stress from tensile to compressive can be controlled in real time.
- Plating rates are faster than with electroless deposition (6.35–25.4 µm/hr).
- Plating is highly efficient (~90% at 45 °C).
- Process requires less maintenance, has low ventilation needs, has a low operations cost, and exhibits less burn and fuming than conventional techniques.
- Versatile process can accommodate a variety of nickel alloys, from nonmagnetic to highly magnetic.
- The technology offers a very long process life span because it does not suffer from solution-phase precipitation, which requires constant stripping of equipment.

National Aeronautics and Space Administration

The Technology

NASA Marshall Space Flight Center has developed an innovative new process for electroplating nickel-phosphorous and nickel-cobalt-phosphorous into high-quality, ultra-hard coatings. These metals usually are deposited onto parts by electroless deposition, which involves placing the part in a bath containing nickel ions that evenly coat all exposed surfaces. Although it yields a high-quality coating, electroless deposition does not allow for much process control, requires high processing temperatures, and has a slower deposition rate than with electroplating. Better process control is available through electroplating, which involves placing a voltage across a nickel electrode (i.e., anode) and the part in a solution (i.e., cathode) and thus driving the nickel to coat the part via electrolytic processes.

Since NASA needed hundreds of high-quality X-ray mirrors for its next generation X-ray observatories, researchers sought to develop a metal deposition process that yielded high-quality coatings similar to electroless deposition but with the process controls provided by electroplating. This technology is the result of their extensive research.

NASA Marshall's technology enables stress-free plating, deposits glassy metal alloys at higher rates, and provides deposition at a much lower processing temperature than with electroless deposition. Plating rates are constant and predictable, and coatings can be extremely hard. The versatile process can be used to electroform free-standing shapes with any specified size or thickness using soluble anodes for metal replenishment. Coating materials can range from nonmagnetic to highly magnetic metals, metals with glassy nickel properties, free machining alloys, corrosion-resistant alloys, decorative blue oxides, and nonreflective black oxide. This process also mitigates the need for constant chemical metal replenishment. The phosphorous is replaced at 1:1 consumption, unlike the 5:1 rate of electroless processes. Buildup of harmful by-products is minimal, and solutions can be left unattended for very thick deposit growth. These features result in a safer and more environmentally favorable process.

Commercial Applications

- Telescopes, microscopes
- Compact discs
- Computers
- Chromium replacement
- Automobiles
- Decorative, wear-resistant, corrosion-resistant coatings
- Molds
- Aircraft, military components

Commercial Opportunity

This technology is part of NASA's technology transfer program. The program seeks to stimulate commercial use of NASA-developed technologies. A patent application has been filed for this technology, and NASA Marshall Space Flight Center seeks companies interested in licensing it for commercial uses. NASA is flexible in its agreements, and opportunities exist for exclusive, nonexclusive, and exclusive field-of-use licensing.

For More Information

If you would like more information about this technology or about NASA's technology transfer program, please contact:

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More information about working with MSFC's Technology Transfer Department is available online.