New Coating Methods To Reduce Waste and Hazards in Plating

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Environmental Problem

Electroplating is used for components and equipment in all fields of technology to protect materials against corrosion, improve surface properties, and achieve optimum decorative effects. A number of wastes that are hazardous to human health and the environment are commonly generated by the electroplating industry. Conventional physical vapor deposition (PVD) techniques, also known as vacuum coatings, have not been able to compete economically with electroplating in large-scale production. A substantial amount of coating material is wasted on chamber walls and fixtures, causing higher operating costs. Only vacuum-based techniques can deposit most metals and alloys, a large number of compounds and polymers, and ceramic or glassy materials on most types of solid surfaces. Therefore, conventional PVD techniques have established a niche in the semiconductor, optical, electronics, and several other high-technology fields.

SBIR Technology Solution

With support from EPA's SBIR Program, IonEdge Corporation developed dry plating methods that offer a substantial improvement over conventional PVD techniques. Dry plating can be used for relatively thick (more than 5 μm) metal coatings. Dry plating production operation for commercial parts received for coating consists of degreasing, dry plating, and inspection process steps (eliminating several hazardous steps associated with electroplating). Dry plating uses two different methods based on the physical properties of the vapor material deposited: (1) the cadmium coating method; and (2) the chromium, aluminum, and other metals coating method, which is used above the melting point of about 650°C.

In the cadmium coating method, cadmium vapors are reflected from all directions so that the coating is uniformly three-dimensional. This is called zero-waste dry plating (Z-PVD) because there are no deposit accumulations on vessel walls and loading racks. The many advantages of the Z-PVD form of dry plating over conventional PVD include: (1) coating time is reduced from 1.5 hours to 15 minutes, (2) no emission of toxic cadmium particles, (3) no weekly downtime for hazardous wall scraping, (4) no frequent loading-rack chemical stripping, (5) zero waste and hazards, and (6) no embrittlement of high-strength steels.

For higher temperature melting materials, IonEdge developed the cathodic arc coating method. In this method, a target such as chromium is mounted on a cathode. The cathode-target pair is mounted in the vacuum vessel. An electric arc is struck between the vessel walls (anode) and the target (cathode). The arc instantaneously vaporizes a spot on the target and ejects vapors toward parts placed on a table below the target. The arc spontaneously and randomly moves on the target, vaporizing the target surface continuously. As the arc current is increased, the vaporization and deposition rates increase.

The chromium, aluminum, and other metals method is capable of coating most metals on any vacuum-compatible solid substrate, conductive or nonconductive. This method can be used in decorative, electronics, electromagnetic interference shielding, and cutting-tool markets. Also, this method is technically capable of depositing precious metals such as gold, silver, and platinum.

Commercialization Information

Dry plating has been developed and commercialized by IonEdge Corporation over a period of 10 years. The technology has been developed primarily under funding from the EPA SBIR Program as an

IonEdge's dry plating process is cost competitive with conventional electroplating of various metals. Pictured above are products produced using IonEdge's PVD method.

alternative to existing electroplating for coating various metals on industrial objects. The cadmium coating method has received a U.S. patent, and the chromium, aluminum, and other metals (above 650°C) coating method has a U.S. patent pending; several more patents are anticipated.

The first commercial sale of IonEdge's dry plating process was to an aerospace customer who requested IonEdge to set up three additional processes to complete their plating line. The expanded plating line and processes have been certified for coating aerospace parts, and IonEdge continues to provide coating services to the aerospace industry. In 1 year, more than 50,000 steel components were cadmium dry plated on this plating line. These components now are in service in commercial airplanes, jet fighters, helicopters, and missiles.

IonEdge is preparing a business plan for expanding the dry plating line to increase the throughput by an order of magnitude (in the range of 2,000 parts of 1-inch size/hour). Simultaneously, a full commercial production plating line will be installed for high-volume parts processing (10,000 parts/hour), which will allow customers to evaluate the full economic benefits of the dry plating process.

Company History and Awards

IonEdge Corporation was founded in 1988, with the goal of developing environmentally safe coatings. The Fort Collins, Colorado-based company has a successful track record of inventing, developing, and commercializing novel waste-free coating technologies. As a result of outstanding technological contributions over the years, IonEdge Corporation was awarded the 1998 Tibbetts National Award for its accomplishments under the SBIR Program. IonEdge also received the 1997 Franklin-Jefferson award from the SBIR-West Regional Council.

SBIR Impact

- Several wastes such as mercury and chromium that are hazardous to human health and the environment are commonly generated by the electroplating industry.
- IonEdge Corporation developed a relatively simple, environmentally friendly, economical, physical vapor deposition (PVD) dry plating process.
- Dry plating eliminates solid wastes and hazardous chemicals and emissions from the plating process.
- Dry plating is cost competitive with conventional electroplating of chromium, copper, nickel, and various other metals and allows for a cost reduction in PVD coating.