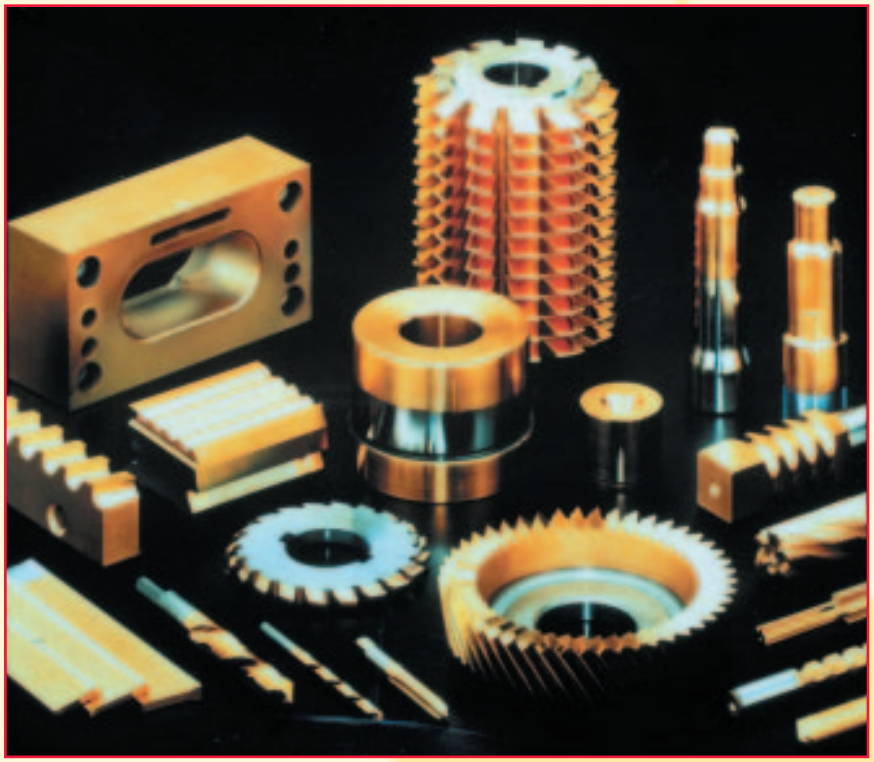
Michigan Finisher Provides PVD Coatings To Extend Wear-life & Corrosion Resistance For Functional & Decorative Applications



Improving the useful wear-life of cutting and forming tools such as these is a major benefit of the PVD process. (Photos courtesy of Gold Star Coatings, Inc.)

Gold Star Coatings, Inc., with facilities located in West Branch, MI, and Richmond, IN, specializes in physical vapor deposition (PVD) coatings to provide hard, wear-resistant finishes for simple and complex-shaped parts and cutting tools. The PVD finishes have been shown to increase the wear-life of tools by as much as 10 times.

Gold Star Coatings got its start by providing titanium nitride (TiN) coatings for hobs and other gear cutting tools for the gear manufacturing industry. Since then, the use of this specialized PVD process has expanded into other areas. Users of products produced by a wide range of cutting tool and wear parts manufacturers are now realizing extended life of tools and extended corrosion and wear-life on decorative components.

Functional Coatings

Three different functional PVD coatings are provided by Gold Star. The most common coating used is the previously mentioned TiN, a gold-colored coating that provides excellent wear resistance on virtually any substrate. Joel Erickson, production supervisor at Gold Star, says forming operations can expect a decrease in galling and welding of workpiece material, and an improvement in surface finish of the formed part with the TiN application. The useful life of most tools treated with this process is about 200–300 percent, although some applications improve tool life as much as 800 percent more than uncoated tooling.

Gold Star titanium carbonitride (Ti[C,N]) is bronze in color and provides improved wear resistance with abrasive, adhesive, or difficult-to-machine materials, such as cast iron, aluminum alloys, Inconel, and titanium alloys. With this process, feeds and speeds can also be increased, and tool life can improve by as much as 800 percent. Forming operations with abrasive materials receive improvements that surpass those with TiN.

Titanium aluminum nitride ([Ti,Al]N) is a high-performance coating that excels at machining of abrasive and difficult-to-machine materials, such as cast iron, aluminum alloys, tool steels and nickel alloys. Purple/black in color, (Ti,Al)N's improved ductility makes it a good performer for interrupted cutting operations. Its high oxidation resistance performs well in high temperature machining, usually associated with the use of little or no coolant. It has also shown excellent properties while dry-machining with carbide tooling.

Characteristics

The PVD process for functional coatings at Gold Star is normally applied at a nominal thickness of 2–4 microns (about .0001–.0002 in.). The coating thickness is minimal, so the dimensional change in the part caused by the surface application used is only about .0001 in., according to Erickson. The low temperature of the process (about 850 °F) does not cause any dimensional change of properly heat-treated substrates.

TiN has a hardness of about 2800 Vickers compared to high-speed-steels, which is on the order of 800–850 Vickers. The process usually duplicates the surface of the part to which it is applied—if a 16-micro finish is present before coating, a 16-micro finish will be present after, Erickson says. PVD coatings should not be used to build up or restore the dimensions of a part.

TiN's thermal stability at cutting and forming temperatures minimizes galling and welding of workpiece material.

Most metals can be coated with the TiN process. Ferrous and non-ferrous metals can be finished without metallurgically changing the substrate.

Conditions

The condition of tools before coating is extremely important. Ground or polished finishes provide excellent adherence of high-quality coatings. Oxide or unground finishes require physical blasting techniques that usually result in a rougher surface and a higher coefficient of friction during use. Generally, tool users and manufacturers should provide the smoothest possible finish, free from burns, burrs, etc.

Different types of tools can be mixed in a cycle, sometimes giving customers a cost or delivery advantage in production. Gold Star can also re-finish some types of used tools, but Erickson said all used tools must be properly prepared for coating (re-sharpened, de-burred, etc.) before they can be processed.

Pricing of PVD

At Gold Star, the prices are primarily based on three criteria—part configuration, overall dimensions and quantity. Other considerations include cleaning requirements, special fixturing and handling for non-standard items.

Decorative Coatings

Gold Star also provides decorative coatings to a number of companies, each unique to a specific market. Items such as emblems, plumbing fixtures, window and door hardware, writing instruments and hair clipping instruments are coated. TiN, (Ti,Al)N and ZrN (zirconium nitride) are all offered in decorative applications. The benefits of decorative PVD coatings include enhanced oxidation/corrosion resistance, finish durability, color enhancement and cosmetic appeal.

High-quality finishes like the one on this hood ornament are offered with the PVD process.

Quality Control

At Gold Star, written operating procedures are in place for all process functions. The Quality Coordinator and process teams have developed a quality manual that covers items such as policy and format, general procedures, annual quality improvement goals, statistical applications and material control. The quality manual ties all of the quality system elements together and is updated as improvements are made.

Control charts are used during the coating process and at final inspection. Variables charts (X bar and r) are used at every opportunity. Other statistical tools that are used include attributes charts (P and nP), process capability studies (CpK), failure mode and effects analysis (FMEAs), cause and effect analysis (fishbone), control plans and problem solving (8D).

The quality system has been audited by a number of major automotive and tooling suppliers, as well as decorative component manufacturers, resulting in certification of the facility as a preferred supplier.

This plumbing fixture is an example of a decorative and functional application of vacuum coating.

Changing for the Future

As market conditions change, so will Gold Star Coatings. Erickson said emphasis will continue to be placed on innovative ways of meeting the quality requirements of customers on a timely basis. The company is also pursuing the development of alternate coating systems to insure that all of the current and future needs of its customers are met. P&SF