New Electrolytic Iron Plating Process Provides Tough Coating Without Hazards

By Charles F. Lowrie

In 1993, Van der Horst U.S.A. Corporation, Terrell, TX, initiated a project to develop an electrolytic pure iron plating process* in a state previously unexplored or utilized. Van der Horst U.S.A. is a re-manufacturer of large power cylinders, castings and other large machinery parts, so the process was originally tested by the company to compare it to other processes in use. The proprietary process, which is a major modification of the conventional iron plating bath used by the company, offers an alternative to industrial hard chromium, as well as other commonly used methods for reclamation, such as thermal spray coatings and sleeving.
Since its initial introduction, the new iron plating process has performed better than what is normally expected of conventional coatings. The process is being used for reclaiming large power and compressor cylinders, for enhancing the performance of new cylinders and other reclamation techniques.

*Vanderloy CL2000, Van Der Horst U.S.A. Corporation, Terrell, TX

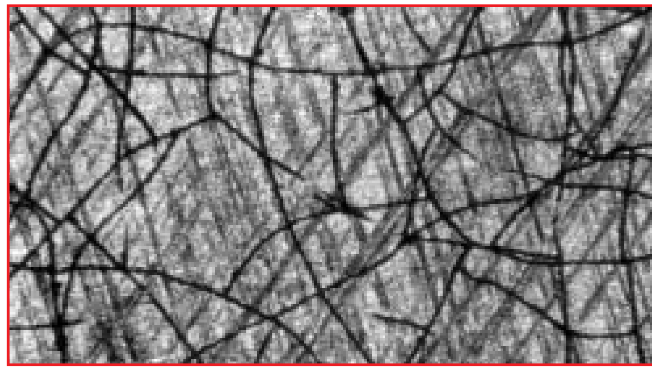


Fig. 1—A typical porosity pattern of the new iron.

Electrolytic hard iron has been produced and utilized for a number of years. Its use, however, has usually been limited to applications where wear resulting from lack of lubrication was not a consideration. These processes were able to produce hard iron, which was dense, with limited or no controlled lubrication. In most applications, procedures to induce oil-containing reservoirs to improve lubricity have been mechanical, laser or electrochemical etch in nature. In contrast, this new proprietary process produces a hard iron with an inherent network of channel-type porosity similar to that found in industrial chromium. The depth of the channels in chromium, however, are typically 0.001 in. to 0.003 in. deep, limiting its life when worn below the channel depth. This new technique of producing electrolytic hard iron produces inherent channels to any desired depth. Channels that are 0.0005 in. to less than 0.010 in. deep are optimum for most applications.

Channels never extend into the interface of the base metal and the electrodeposit. The area, or size of the plateau between channels at the surface, is variable and controllable to close tolerances and can be patterned to suit the ultimate application of the deposit. (see Figs. 1 & 2).

Characteristics

Characterized by dense, fine-grained, columnar microstructure, the process is molecularly bonded to a wide variety of basis metals (see Fig. 3). Its microstructure enables it to resist wear and coining, and adhesion is so strong that the base metal will

Note the pulling away of the basis metal with electroplate in this example of the push-out test.

Magnified to show oil-retaining reservoirs.

Fig. 2—A magnified cross section of a deposit on cast iron, and the results of a routine bond check.

typically fail prior to the deposit. The finish offers a preplate selection of hardness ranging from 35 to 55 Rc, depending on the desired application. Its tensile strength averages 235,000 psi and shear strength exceeds 50,000 psi. The hardest portion of the deposit is typically an average of 0.008 in. thick nearest the outer surface (see Fig. 4). Up to at least 0.500 in. of coating, however, may be uniformly deposited if necessary or desirable. The latter is achieved by depositing an underlay of iron of a lesser hardness so that it does not create undesirable stress and weakening of the parent part.

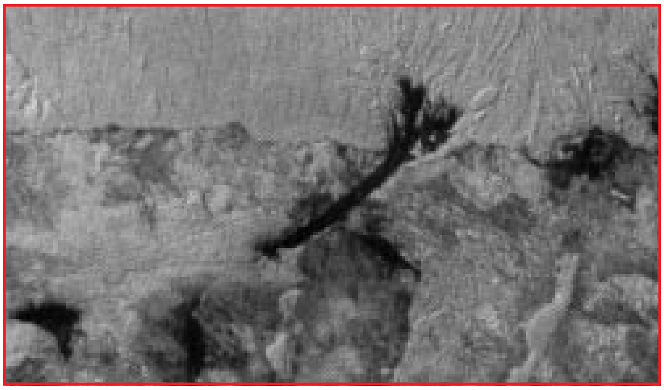


Fig. 3—This magnification of the new iron electroplate and cast iron interface shows the molecular bond of the plating to the basis metal. (Note flake of graphite extending into the electroplate.)

Parts That Can Be Plated

Large, mis-machined, worn or new compressor and power cylinders, as well as engine parts, are examples of favorable candidates for the new technique. In many instances, the process actually improves the strength, durability and performance of the virgin part. As a reclamation or recycling technique, the coating permits the restoration to service of worn parts that would otherwise not have been economically feasible. The cost is also substantially less than many other coating procedures.

Environmental Aspects

From an environmental standpoint, the electrolytic iron finish is attractive. It involves a process that is environmentally friendly, because all chemicals used are nonhazardous, or can be easily rendered nonhazardous. The chemicals used in the process are readily available in the U.S., eliminating the dependency on foreign sources, which is the case with chromic acid used in the production of hard chromium. The iron bath produces a deposit that is independently functional, and it also performs quite harmoniously when combined with its conventional counterpart, which is a proprietary iron plating product typically used as an underlay for chromium.

The Push-Out Test

The "push-out test" is a destructive procedure to evaluate adhesion of a coating to its basis metal. Briefly, it involves drilling a 0.2587 in. diameter blind hole from the underside of the specimen into the basis metal to a depth of 0.625 in. from the interface of the coating and the basis metal. The specimen is placed coated side down on a metal support with a one in. diameter hole. A 0.250 in. hardened steel rod is placed in the blind hole in the specimen, which is centered on the large hole in the support. By raising this arrangement with a hydraulic jack to a stationary bridge, the rod is pressed against the specimen. Examination of the resulting "button" and of the periphery of the "crater" under a microscope leads to a classification of the quality of adhesion. An excellent bond will result if there is no "clean" (or smooth) separation directly at the interface. In other words, all of the coating should have the basis metal still adhering after being broken out (see Fig. 2). P&SF

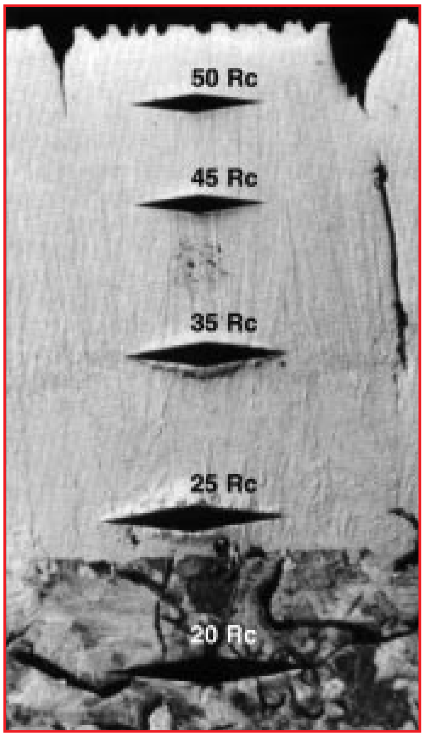
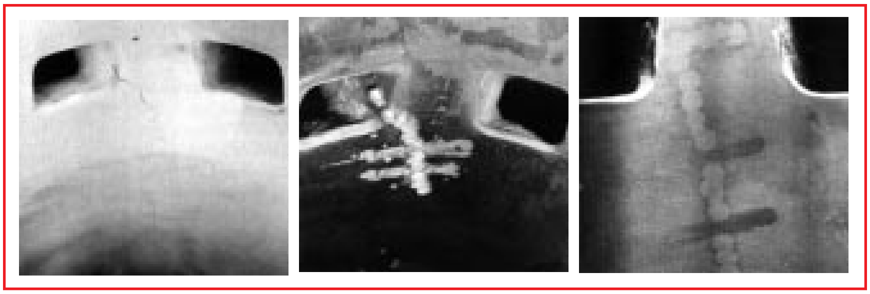


Fig. 4—These indentions were produced by microhardness testing of a cross section of the new iron finish.



The cylinder repair method used by Van der Horst U.S.A. combines plugging, cross-stitching, if required, and machining. After being repaired, the part is hydrostatically tested before plating. At left is a cylinder bore with a crack extending from the bore into the port. The middle photo shows the plugs and stitching before being ground and machined. At right is the completed repair before plating. In most instances, the repair will be completely covered by the plating.

About the Author

Charles F. Lowrie is technical director of Van der Horst U.S.A. Corporation, P.O. Box 428 Terrell, TX 75160. He holds BS and MS degrees from East Texas State University where he majored in mathematics with minors in physics and chemistry. In 1964, he began working for Van der Horst Corporation of America, one of the largest industrial hard chromium/iron electroplaters in the world. In 1987, the company was sold and became Van der Horst U.S.A. Corporation. He has served as technical director since 1989.