Can You Imagine . . .

. . . a new processing alternative that treats machine components, altering their surface layers to improve durability and resistance to corrosion.

NEW PROCESS ALTERNATIVE PROMISES HARDER MATERIALS

When manufacturing such heavy machinery as automobiles, hardness and durability are two qualities essential to satisfy quality-seeking consumers. The low-wear requirements of the machines that manufacture these products also make these qualities essential to manufacturers.

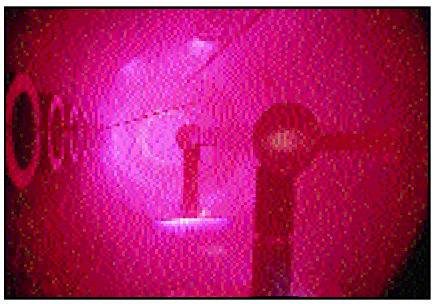
Through an Advanced Technology Program-sponsored project, a consortium of 14 participants is addressing these qualities, scaling up a technology called plasma source ion implantation (PSII). Rather than coating industrial parts, which must be toughened to survive severe environments, PSII actually changes the material surface, providing performance and environmental advantages over other hardening methods. It uses a power modulator derived from BMDO-funded work on the particle beam accelerator developed at Los Alamos National Laboratory (LANL; Los Alamos, NM).

GENERAL MOTORS IS INVESTIGATING PSII TO CHANGE THE SURFACES OF LIGHTWEIGHT ALUMINUM AND MAGNESIUM ALLOYS USED IN ENGINES.

This process can be used to harden components for automobiles, aircraft, power plants, and prosthetics. For example, General Motors is investigating PSII to change the surfaces of lightweight aluminum and magnesium alloys so they can withstand the high wear and harsh environment found in engines. Substituting these materials for steel and iron could result in a 10 percent decrease in the cost of making automotive power trains.

In addition, treating production machine parts themselves increases their service lives for manufacturing, thereby reducing associated costs and downtimes in manufacturing plants. In a study comparing the service lives of steel-tool punches, nitrogen-implanted punches using PSII lasted two times longer than chrome-only plated punches and five times longer than untreated punches. With further development, some dies and tools may last 10 times longer than their untreated counterparts.

The modulator used to control the voltage output from the power source came from the BMDO-funded Ground Test Accelerator project at LANL. Built as a follow-on to the Beam Experiment Aboard Rocket project, the Ground Test Accelerator, a cryogenically cooled device, was developed to provide a model of a space-based neutral particle beam weapon.



■ Rather than coating the material, PSII modifies its surface. Pictured above is a look inside the PSII chamber.

ABOUT THE TECHNOLOGY

In PSII, injecting a low-pressure gas, such as nitrogen, into a steel vacuum chamber hardens the material. The nitrogen ionizes into a plasma using oscillating radio frequency waves, and it strips electrons from the gas atoms. Then, exposing the material to short pulses of negative voltage causes positive-charged ions to accelerate toward the negative-charged material, bombarding it from all sides. The ions penetrate and modify layers of the material near the surface. This process can treat polymer surfaces as well as metals.

The process offers several advantages over other hardening methods. For example, since PSII is not a coating, adhesion and delamination are not concerns. Less expensive and with a higher average current (1.00 ampere versus 0.03 ampere) than line-of-sight implantation processes, it permits much faster implantation. Also, PSII does not require masking or expensive fixtures to manipulate nonplanar parts, and it evenly treats such odd-shaped items as power tools, door locks, and drive trains. An environmentally benign “dry” alternative to the wet chemical baths used in electroplating, the process does not produce effluent pollutants.