

Know your WHEEL

Grinding wheel selection affects grind time, surface quality

BY LOU PADMOS

To combat the wear and corrosion that happen to aircraft landing gear components, they have been hard-coated for many decades. Originally coated with hexavalent chromium, these parts were then ground using ruby-based aluminum oxide or silicon carbide-based abrasives.

This electrolytic hard chrome (EHC) plating process is a coating technique that has been around for more than 60 years. It is a crucial process used to apply hard coatings to a variety of aircraft components in original equipment manufacturing operations and for general rebuild of worn or corroded components removed from aircraft during their overhaul. In particular, chrome plating is used extensively on landing gear components such as axles, hydraulic cylinders, pins, and journals.

Although polishing generally was not needed, the coatings were then sometimes polished by superfinishing techniques with tapes, pastes, or stones if the ground surfaces were not smooth enough for critical sealing applications.

Tighter U.S. Environmental Protection Agency and other worldwide environmental regulations governing the release of hexavalent chromium emissions into the atmosphere and disposal of hazardous liquid and solid wastes have made hard chrome plating of commercial and military aircraft parts economically, environmentally, and politically unsustainable.

ENTER HVOF

High-velocity oxygen fuel (HVOF) spraying of coatings was developed to apply ultra-

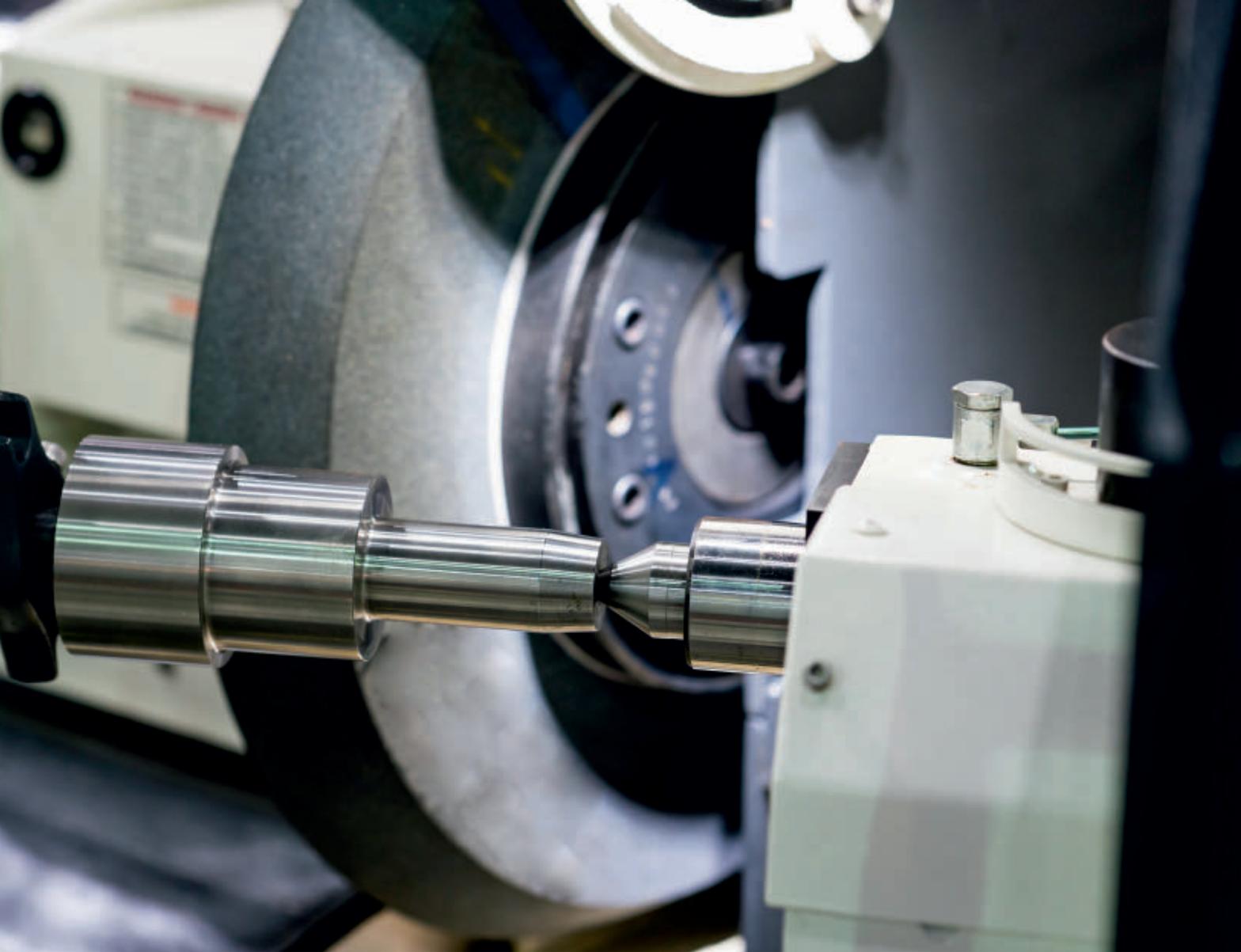


hard, corrosion-resistant coatings to steel substrates. Tungsten carbide powders are injected into a high-velocity stream of fuel and oxygen to atomize and supersonically impinge on the surface of the part to be coated. A coating thickness of several mils to 0.5 mm is built up quickly using this process.

Grinding these coatings has to be done with diamond grinding wheels because of their extreme hardness and their thickness. Jon Devereaux pioneered this work at NASA, which sponsored the first specification governing the grinding of HVOF coatings. This specification came to be known as AMS2449.

Development was done with the dominant wheel bonding system of the day, phenolic resin. Since then producers of high-strength steel landing gear parts were regulated and restricted to using diamond-impregnated grinding wheels held in phenolic resin bonds to grind these parts, albeit with some difficulty.

Resin-bonded wheels by their nature are



closed-structured tools and are prone to glazing or loading with ground material. Wheels typically were trued with a diamond tool or brake-controlled truing device using a silicon carbide (SiC) wheel. Then the wheel face was opened up for grinding by hand sticking it with an aluminum oxide abrasive stick. This sometimes was done offline on a separate machine.

This method was not only time-consuming and cumbersome, but when the wheel was removed from the grinder and then reinstalled, errors could be introduced.

New safety regulations also don't allow operators to open doors on running machines or interact with grinding wheels running at speed. This is another reason that manufacturers started asking for a better system.

VITRIFIED DIAMOND TECHNOLOGY

Vitrified diamond technology has been around since the 1980s, when it was developed primarily to grind ceramics and carbide

tools. The predominant advantages of "vit" diamond over resin diamond wheels are the natural porosity in the wheel structure, which allows cooler grinding; better swarf removal; and more importantly, wheel dressability.

Truing and dressing are carried out simultaneously with a high-speed rotary diamond dressing spindle and diamond-impregnated disc. Wheels can be trued with the disc rotating unidirectionally with the wheel at the point of contact and dressed rotating in the opposite direction or counter-directionally for a better finish.

High-precision spindles and diamond dressing discs are suitable for this task with high stiffness, smooth operation, and axial and radial runout values of 2 microns or better.

THE PROOF

To prove the value of the new technology, S.L. Munson & Co. conducted grinding wheel studies on an instrumented Blohm grinder.

Resin-bonded grinding wheels of known quality in 120-grit and 400-grit diamond were compared to vitrified bonded diamond grinding wheels supplied by Krebs & Riedel GmbH. Spindle power, volume of material removed, measured material removed versus grinder setpoint, and surface finish were measured.

The new resin wheel cut easily, but spindle power quickly rose linearly until it stabilized at 8 HP as measured by the instrumentation hardware and software. The vitrified wheel started out at 4 HP and rose to a peak of 5 HP, or 62 per cent of the resin wheel. The resin wheel power demand doubled, while the vit wheel power demand increased only 25 per cent.

This indicated cutting ability or freeness of cut. This is better for the parts and coating and better for long-term longevity of the grinder. The results were repeatable and ran true for different depths of cut on both the 120-grit wheel and the 400-grit wheel.

Vitrified wheels also remove material without glazing, loading up, and deflecting. Shop floor operators tend to creep up on their final size when using a resin wheel and don't take off as much material as the grinder was programmed to remove.

Resin wheels tend to be manufactured using aluminum, bakelite, and sometimes carbon fibre cores, but the first two materials can deflect and absorb some of the machine infeed, especially if the wheel is not cutting freely. When this occurs, the wheel springs back, and sometimes operators overshoot and



High-velocity oxygen fuel (HVOF) spraying of coatings was developed to apply ultrahard, corrosion-resistant coatings to steel substrates. The hardness and thickness of the coatings makes them difficult to grind. Photos courtesy of Hitemco.



Test wheels after grinding show resin wheel loaded with TC coating. Photos courtesy of S. L. Munson & Co.

grind very expensive parts undersize, leading to a trip for rework and respraying in the coating booth.

Parts measured after grinding tests confirmed the vitrified wheels removed more material and achieved a size very close to what was programmed into the grinder to be removed. Surface finishes, as expected, were higher for the vitrified bonded wheels, about 50 per cent higher, under the same grinding parameters. This was expected because these wheels are porous and free-cutting.

Resin wheels do generate better surface finishes both when new or when freshly stick-dressed, but as they are used and glaze up, they rub more than they grind. Vitrified wheels can not only be lightly dressed slower to achieve a good finish after rough grinding, but finer-grit diamond sizes also can be used. A 240-grit vitrified wheel can grind just about as fast as a 120-grit resin-bonded wheel and achieve the same finish.

AMS2449, *Grinding of HVOF Sprayed Tungsten Carbide Coatings Applied to High Strength Steels*, served the aerospace industry well for more than 20 years, but as with everything in life, things change, hopefully for the better with new technology replacing older technology.

The new AMS2449A allows manufacturers of these parts to continue to use resin-bonded wheels if that is their comfort level and state of their equipment, but it also allows the use of the latest vitrified bonding technology and rotary diamond dressing technology available today to produce better parts first pass, in less time, more efficiently, and at lower costs to the benefit of the industry. **CM**

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