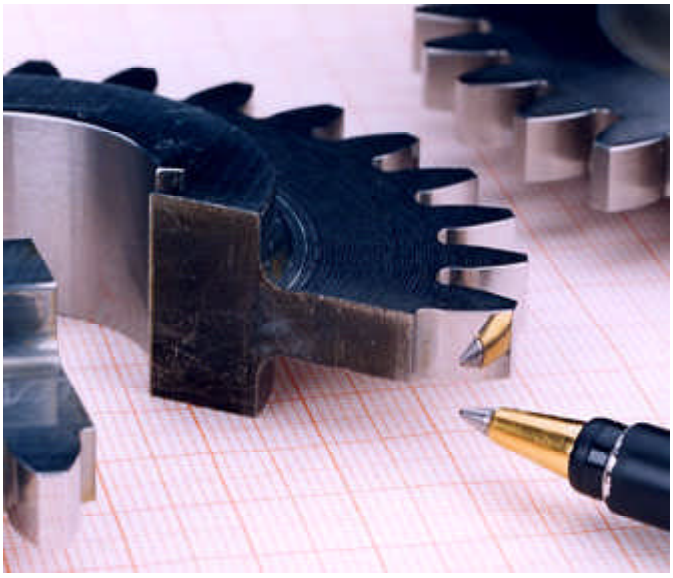
Gear Durability Shown To Be Improved by Superfinishing



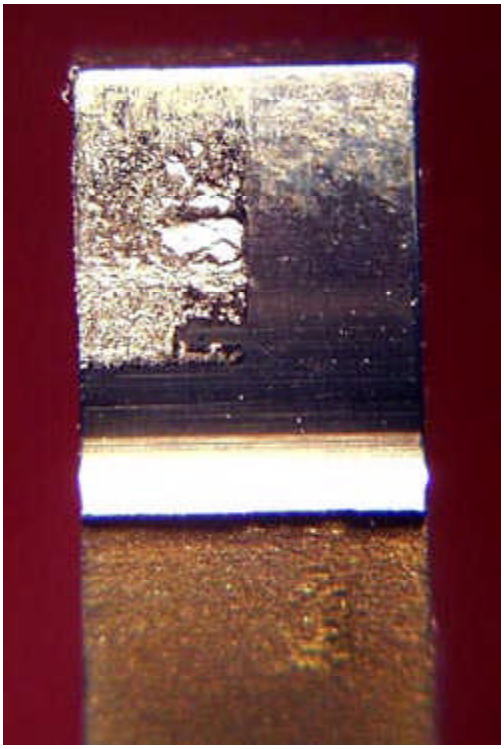
Highly polished surface of a superfinished gear.

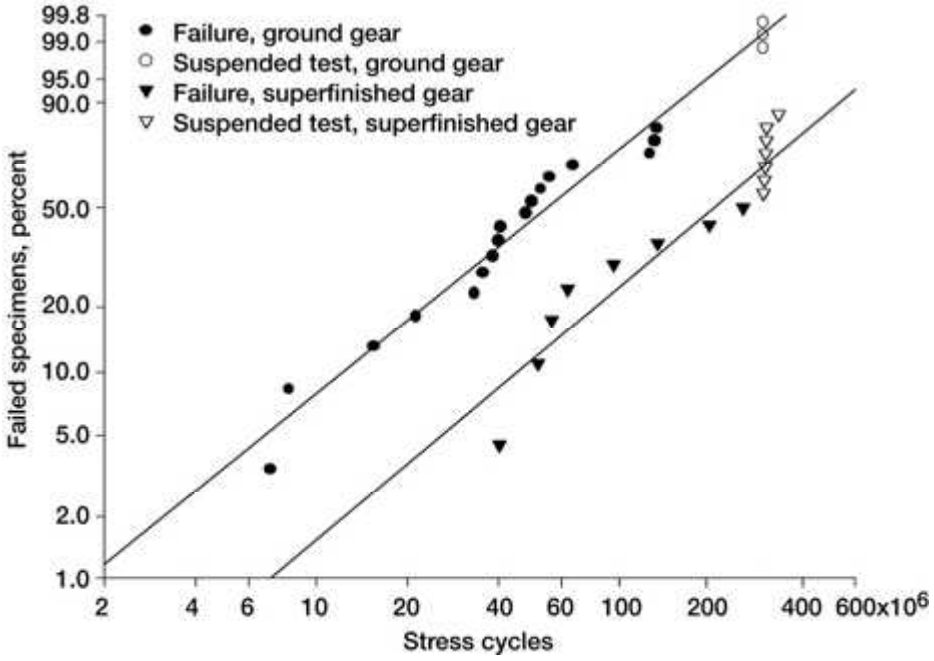
Gears, bearings, and similar mechanical elements transmit loads through contacting surfaces. At the NASA Glenn Research Center at Lewis Field, we postulated that the fatigue lives of gears could be improved by providing smoother tooth surfaces. A superfinishing process was applied to a set of conventionally ground, aerospace-quality gears. This process produced a highly polished, mirrorlike surface as shown in the preceding photograph. The surface fatigue lives of both superfinished and conventionally ground gears were measured by experiments. The superfinished gears survived about four times longer than the conventionally ground gears.

These superfinished gears were produced from conventionally ground, aerospace-quality gears whose geometry had been inspected. The gears were superfinished by placing them in a vibrating bath consisting of water, detergent, abrasive powder, and small pieces of zinc. Upon removal from the bath, the surfaces were highly polished, as depicted in the preceding photograph. The gears were again inspected, and dimensional measurements made before and after the superfinishing operation were compared. Superfinishing removed the peaks of the grinding marks and left a much smoother surface. Profile and spacing checks proved that the overall gear tooth shape was not affected in any harmful way. Superfinishing uniformly removed approximately 2.5 μm from each surface. See reference 1 for a complete report.

Superfinished 28-tooth, 8-pitch gears made from AISI 9310 steel were tested at Glenn at a hertzian contact stress of 1.71 GPa (248 ksi) for 300 million cycles or until surface failure occurred on any one tooth as illustrated in the following photograph. The fatigue data,

shown on Weibull coordinates in the graph, were analyzed using the method of reference 2. The lives shown are the lives of gear pairs in terms of stress cycles or revolutions. The lives of the superfinished gears were about four times longer than those of conventionally ground gears. The confidence number that the 10 percent life of the superfinished gears is greater than the 10 percent life of the conventionally ground gears is more than 90 percent, a statistically significant result.





Top: Typical surface fatigue failure. Bottom: Weibull plot of gear fatigue experiments.

This work was done as a partnership between NASA, the U.S. Army (Army Research Laboratory and The Army European Research Office), and the University of Wales.

Find out more about this research http://www.grc.nasa.gov/WWW/5900/5950/.

References

1. Snidle, R.W.; Evans, H.P.; and Alanou, M.P.: The Effect of Superfinishing on Gear Tooth Profile. Report AD–A327916, June 1997. Available from the Defense Technical Information Center (DTIC), the National Technical Information Service (NTIS), or the Center for AeroSpace Information (CASI).

2. Johnson, L.G.: The Statistical Treatment of Fatigue Experiments. Elsevier Pub. Co., New York, NY, 1964.

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