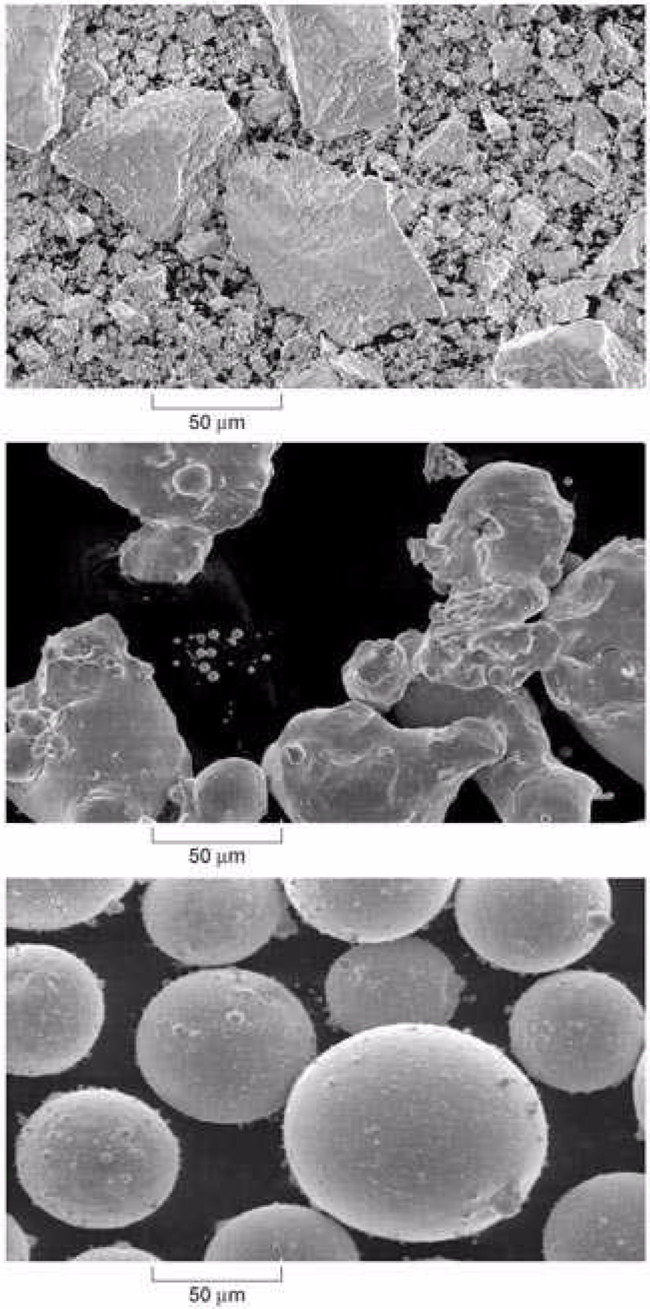
Commercialization of NASA PS304 Solid Lubricant Coating Enhanced by Fundamental Powder Flow Research

The NASA Glenn Research Center has developed a patented high-temperature solid lubricant coating, designated PS304, for reducing friction and wear in bearing systems. The material used to produce the coating is initially a blend of metallic and ceramic powders that are deposited on the bearing surface by the plasma spray process. PS304 was developed to lubricate foil air bearings in Oil-Free turbomachinery, where the moving surfaces are coated with a hydrodynamic air film except at the beginning and end of an operation cycle when the air film is not present. The coating has been successful in several applications including turbochargers, land-based turbines, and industrial drying furnace conveyor components, with current development activities directed at implementation in Oil-Free aeropropulsion engines.

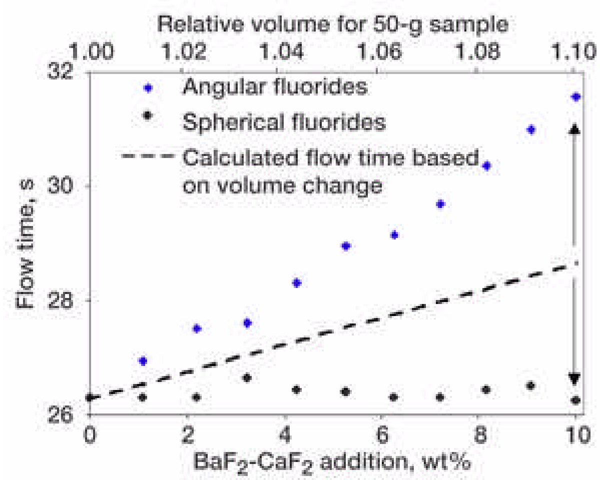
For the PS304 coating to be transferred to industrial use, the deposition process must be predictable and the coating material cost should be low. Since the early development of PS304, problems have sporadically surfaced where the powder blend would clog in the deposition equipment (powder hoppers, feed lines, and spray gun nozzles). The reasons for this behavior were unclear and appeared to be unrepeatable from powder batch to batch.

Anecdotal evidence suggested that high humidity and feedstock particles that were too small interfered with deposition reproducibility, so Glenn researchers conducted a series of controlled experiments to investigate the problem. In typical laboratory conditions, Glenn researchers found that the shape and the size of the feedstock particles were more important than humidity for effective control of the deposition process. An additional benefit of this study was the development of a novel powder fabrication process for one of the components of PS304.



Ceramic solid lubricant particles in PS304. Using rounded or spherical particles, respectively, gives increasingly better flow properties to the feedstock powder blend. Top: Angular morphology. Center: Rounded morphology. Bottom: Spherical morphology.

The ceramic material that provides high-temperature solid lubrication in the coating, BaF_2-CaF_2, is traditionally made in a manner that generates many small, angularly shaped particles (top photomicrograph), which impede powder flow and affect the deposition process. In the new process, this constituent was made by melt atomization such that the resultant powder particles were smooth with far fewer fine particles (center and bottom photomicrographs). Feedstock prepared with these powders exhibit improved flowability, lower variance in flow rate, and reduced susceptibility to humidity. As shown in the graph, the angular powder degrades feedstock flow, whereas the spherical powder does not. Recently completed testing shows that the rounded powder follows the line predicted by the rule of mixtures (see the graph). Because the number of steps required to produce the powder by atomization is significantly reduced, the material cost is much lower, enhancing commercial transfer. Licensing agreements are under development for powder production.



Influence of BaF2-CaF2 powder addition on the flow rate of PS304 feedstock.

Find out more about Oil-Free Turbomachinery research http://www.grc.nasa.gov/WWW/Oilfree/.

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Glenn contact: Dr. Malcolm K. Stanford, 216-433-3387, Malcolm.K.Stanford@nasa.gov
Author: Dr. Malcolm K. Stanford
Headquarters program office: OAT
Programs/Projects: Propulsion and Power