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Brief 66-10221

NASA TECH BRIEF

Submicron Metal Powders Produced by Ball Milling with Grinding Aids

The problem:

To produce metal powders of an average particle size of less than 1 micron by ball milling of coarser powders with selected grinding aids. Some of the variables associated with ball milling are the size, material, and construction of the grinding container, the nature and amount of the grinding material and the material to be ground, the nature and amount of the grinding aid and liquid used, and the grinding time. In all ball milling, agglomeration due to welding or flocculation of the particles limits the ultimate particle size that can be obtained. Greater difficulty is often encountered in the grinding of ductile metals (e.g., copper, nickel, silver), because the particles have a greater tendency to weld together than those of brittle or friable metals.

The solution:

In experiments with powdered nickel, iron, chromium, silver, and copper, obtained from commercial sources, various salts (with different ion size, valence, and polarizability) were generally found to be more effective than conventional surfactants as aids in ball-milling the metals into powders having an average particle size down to 0.1 micron. Among the salts found to be most effective were cerium nitrate, aluminum nitrate, sodium dichromate, potassium ferricyanide, potassium ferrocyanide, and sodium pyrophosphate, with absolute ethyl alcohol as the grinding liquid.

How it's done:

Specific amounts of the metal powders with various grinding liquids (including water, absolute ethyl alcohol, cyclohexane, n-heptane, and methylene chloride), various salts, and surfactants were ground with stainless steel balls in a stainless steel milling jar for 2 to 15 days. The grinding effectiveness was determined by measuring the particle sizes of samples taken at various times. Three groups of ball-milling experiments were run, one in which the grinding aid (salt or surfactant) was varied, a second in which the grinding fluid was varied, and a third in which the material being ground was varied. A total of 22 salts, 11 surfactants, 5 grinding fluids, and 11 metal powders (consisting of 5 different metals) were used. Most of the experiments consisted in varying the grinding aid employed and were performed using nickel powder (Inco carbonyl grade B), having an initial particle size of 2.5 microns, as the material being ground and absolute ethyl alcohol as the grinding fluid.

Note:

Further information concerning this innovation is given in NASA TN D-879, "The Production of Submicron Metal Powders By Ball Milling With Grinding Aids" by Max Quatinetz, Robert J. Schafer, and Charles R. Smeal, March 1962, available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia, 22151. Inquiries may also be directed to:

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Lewis Research Center
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Cleveland, Ohio, 44135
Reference: B66-10221

(continued overleaf)

Patent status:

This is the invention of NASA employees, and U.S. Patent No. 3090567 has been issued to them. Inquiries about obtaining license rights for its commercial development should be addressed to the inventors, Mr. Max Quatinetz and Mr. Robert J. Schafer, at Lewis Research Center.

Source: Lewis-188