INFORMATION, HISTORY

POWDER METALLURGY OVERCOMES ECONOMIC DIFFICULTIES

D. A. Levina, L. I. Chernyshev, and N. V. Mikhaylovskaya

UDC 621.762

The state of the production of metallic and ceramic powders (including nano-dimensional powders) and of articles fabricated from these powders in North America is discussed. New technologies that produce an increase in the density and improvement in the mechanical properties of powder-based articles are considered. Technological developments and articles for which prizes were awarded by the North American Metal Powders Industry Federation in 2003 are adduced.

Keywords: fabrication, powder, article, nano-dimensional powder (nanopowder), injection molding, warm molding, surface densification, lubrication, sintering carbidization, high-velocity compaction, hardening, high-temperature sintering.

The International Conference on Powder Metallurgy and Disperse Materials, PM2-Tec2003 (PM2 referring to Powder Metallurgy and Particulate Materials) organized by the North American Metal Powder Industries Federation (MPIF) was held in June, 2003 with 1100 delegates from more than 30 countries around the world present at the conference. In summarizing the development of powder metallurgy in the past few years, David Schaefer, president of the MPIF [1], remarked that the North American powder metallurgy industry has successfully overcome economic difficulties, in particular, a certain drop in industrial production. Radical changes are now occurring in this branch of industry, including a growth in economic efficiency and in volumes of output of alternative powder technologies in the automobile industry, and in the concentration and mergers of industrial plants in powder metallurgy and disperse materials. In noting the expanding technological base of the production of disperse materials, Schaefer underscored [1] what were, he believed, important circumstances, such as the use of modeling in the design of powdered articles, the expanding production of nano- and biomedical materials, as well as the fabrication of powder-based articles without the use of molds.

There has been increasing interest in powder metallurgy and special materials on the part of scientists, as is attested to by the presence at PM2-Tec2003 of delegates from 31 universities from many countries around the world. This interest is connected with the fact that in today’s world the technology of powder metallurgy and special materials is finding increasing use. Nanostructural materials have shown great promise. Though in the course of millions of years Nature has created different nanostructures, today it seems that scientists are only at the start of understanding the special features of the properties and laws governing the behavior of nanostructural materials.

Jim Trombino, executive director of MPIF, believes [1] that despite the economic and geopolitical complications of recent years the North American powder metallurgy industry has retained its strong position. Production of iron powders in North America increased in 2002 by 12.4% and amounted to 394,255 t while production of articles fabricated from iron powders grew during this period by 13% and reached 370,596 t (Fig. 1a). During the same period production of copper powders grew by 9.2% and reached 20,520 t while production of articles fabricated from copper powders grew by 7.1% reaching 17,106 t (Fig. 1b), with 55% of the market of products made from copper...
powders consisting of self-lubricating bronze bearings. The volumes of production of nanopowders, particularly ceramic nanopowders, for use in electronics, chemistry, the energy industry, and for ecological applications increased. It is expected that the market for ceramic nanopowders in North America will grow from $154,000,000 in 2002 to $241,000,000 in 2007.

As before, the principal customer for powder output remains the automobile industry. Despite some recession in this branch of industry in 2003 announced by the “Big Three” (the world’s three largest producers of automobiles, Ford, General Motors, and Chrysler), the powder metallurgy industry continues to receive significant profits from the ever-increasing penetration of powder-based articles into the automobile market. This is due principally to the use in new engines of hot-pressed powder rods and bearing caps fabricated from metallic powders as well as the replacement of molded and mechanically processed high-strength toothed sun-and-planet gears by components fabricated by means of powder metallurgy methods. The expanded use of powder materials may also be seen in the example of different valve systems used in synchronizers; potentially, it may be expected that from 1 to 3 kg of powder articles will be used in these systems per automobile.

Jim Trombino reported [1] that today a typical American automobile contains, on average, 17.6 kg powder-based articles, that is, 4% more than in 2001 (in 1977 the comparable figure was only 7 kg). European and Japanese automobiles remain far behind; in 2002 they contained 8.7 and 7.3 kg of powder-based articles, respectively.

Thanks to economic efficiency, distinctive properties, high quality, and all the other advantages which the technology of powder metallurgy provides, the use of powder-based articles is entirely appropriate for the automobile industry.

The new requirements imposed by automobile designers on powder-based components are related to the need to ensure long-term stability of properties and increase the service life of the components. Designers believe that powder-based articles in automobiles must function without replacement for the entire service life of the automobile, that is, for at least 10 years or 240,000 km. New trends in automobile design involve the replacement of many of the mechanical systems of the drive and control by electrical systems, such as power steering, electrical fluid-flow pumps, and camshaft drives. The powder metallurgy industry must adopt these requirements of the automobile industry and be ready to manufacture innovative products that conform with these requirements.

Jim Trombino and David Schaefer also noted [1] the significant growth in North America in the manufacture of articles fabricated by means of injection molding; production of such articles grew by 15% in 2002. These articles are mainly for use in the automobile industry, medicine, electronics, and home appliances. On the whole the value of the North American market for injection molded products fabricated from metallic powders was estimated to be in the range $100,000,000–$150,000,000 in 2002 while that for products fabricated from ceramic powders, in the range $40,000,000–$80,000,000.

Advances in powder metallurgy have also promoted MPIF activities intended to improve standardization in this branch of industry (e.g., new Standard 35 for structural parts) and the development of powder-based materials for designers [1].

Fig. 1. Production of iron (a) and copper (b) powders in North America in the period from 1990 to 2002. The data are represented in short tons (0.91 t): 1, 4 — articles; 2 — welding; 3, 5 — other applications