Advanced Materials & Nanopowder Industries

Overview

AP Materials, Inc. (APM), develops and manufactures ceramic and metallic powders for use in consumer, industrial, and military applications. The powders are used in both powder form and for starting materials in the production of consolidated (solid or porous) materials. Our primary products are nanoscale powders of metals, alloys, ceramics, and composites.

The Advanced Materials Industry

According to sources such as The Economist, Forbes, Ceramic Industry, Modern Paints and Coatings, and China Chemical Reader, the market for advanced materials such as ceramics and metals has grown enormously over the past five-ten years. By some estimates the worldwide market for advanced materials is over $400 billion annually. The industry is large and experiencing rapid growth because materials are the tangible component of all products. Applications such as biomedical, structural, catalytic, electronic, optical, and magnetic are all subject to the need of property enhancement. Manufacturers will push the envelope to develop the smallest and most versatile cell phone, the strongest medical prosthesis, or the lightest airplane, and in all the applications, a tangible material must exist before that product is realized.

The Powder Materials Industry

The Powder Materials industry is international in scope with growing markets in all of the major industrialized countries. The industry is broad, encompassing materials ranging from ceramics to super-alloys. Powders are currently used in the manufacture of a wide variety of products including engine components, electronic devices, cosmetics, machining tools, medical/surgical instruments, nutraceuticals, paints, coatings, optics, magnetic devices, semiconductors, and graphitic parts. The reasons that powders are chosen for particular applications are diverse. Some incorporate powders into the final product, such as titanium dioxide powders in paints and cosmetics, while other products use powders as starting materials during fabrication because it is economical or a practical requirement. For example, in the automotive industry, metal alloy powders are compacted to produce gears and bearings. This processing technique is preferred because it produces consistent products and eliminates costly machining processes. In the production of ceramic parts powder technologies are a requirement, as the ceramics cannot be economically processed by other methods.
The powder materials industry can be divided into two components: metals, including all types of metallic alloys, and ceramics.

-Metals

The powder metals industry is still young. Although some powder metal applications have been around for thousands of years, a significant number of products and applications began to appear in the 1950s. In its short time frame, the industry has made great advances. The automotive industry, an early advocate of powder metal techniques, now incorporates over 36 pounds of powder metal parts in a typical automobile. Virtually all metals and alloys are likely candidates for a powder process. Platinum powders are used as catalysts, iron and ferric alloy (e.g., stainless steel) powders are used in the manufacture of gears and bearings, copper powder is used in anti-fouling paints for boat hulls and in metallic pigmented inks for packaging and printing, bronze powders are used in the production of numerous complex components, and tantalum powders are used in electronic components. These are just a few examples of metal powders already in use.

Worldwide metal powder production exceeds one million tons each year. North American metal powder shipments alone is over $2 billion and the North America powder metallurgy industry has estimated sales of over $5 billion [Metal Powder Industries Federation, 2000]. The United States, Europe, and China are the largest consumers of powdered metals and the largest developers/researchers of new powder manufacturing technologies.

-Ceramics

Perhaps the advanced materials industry component with greatest potential is ceramics. The worldwide market for advanced ceramics is estimated to be over $25 billion and over $1.1 billion for advanced ceramic powders, according to Business Communications Company of Norwalk, CT.

Due to their high melting points and poor machining characteristics, production of bulk ceramic components must be produced via powder techniques. The unique properties of ceramics make their potential uses endless. For example, aluminum nitride is a very good conductor of heat but it is also an electrical insulator, making it an ideal material for the electronics industry. In the past, production and manufacturing challenges of ceramics have limited the number of applications. Structural ceramics, particularly those based on silicon nitride and silicon carbide, have evolved into true engineering materials. Over a million ceramic turbocharger rotors are currently on the road, operating with high reliability. Other examples include Cummins’ ceramic fuel injector link that has been in use since 1989 and Allied Signal’s ceramic seal runner on the main shaft of its airborne 731 gas turbine engine [Ceramic Industry, April 1999]. The demonstrated reliability and durability of both static and rotating structures has set the foundation for ceramics to be used as widespread engineering materials and their unique properties will ensure rapid market growth.

The Nanopowder Industry

A great need exists for development of advanced powders as applications are being
developed that require materials to perform under extreme conditions. If materials are not available to meet exact design specifications, the final end product will not be realized. High thermal conductivity dielectrics and infrared windows, high temperature engines components, and capacitors with high volumetric capacitance are examples of products that are currently limited by the material specifications. The answers to these and many other applications are nanoscale powders. Nanopowders are powders consisting of particles that are only tens to hundreds of atoms across. This advancement in the Powder Materials industry allows designers to manipulate the materials on an atomic scale. As a result, material properties can be tailored for specific applications.

The Nanopowder industry began to show growth in the late 1980’s. In the current decade, more and more applications have been identified that require nanopowders as starting materials. The average annual growth rate of the industry is estimated to be over 30%. The current deficit in the industry is low cost material production – the market for nanopowders will expand greatly when production methods are identified that are capable of manufacturing consistent materials on a large scale at reasonable prices.