The powder metallurgy (PM) industry continued its moderate growth track in 2016, and most indicators signal a repeat performance for North America in 2017. The year opened on a positive trend, as expected with the changes in Washington, but business levels are returning to a modest growth level as forecast by most informed observers. Conventional press-and-sinter companies and metal powder producers report good business levels, as well as companies involved with metal injection molding (MIM), metal additive manufacturing (AM), and hot isostatic pressing (HIP). The demand for refractory metals has finally started to move upwards.

**Metal Powder Shipments**

The metal powder market reflected a mixed-bag in 2016. End-use sectors experienced a range of modest growth, stability, modest decline, and double-digit weakness. Last year's total iron powder shipments, for example, declined by almost 2,723 mt (3,000 short tons (st)), which is less than 1%, to 381,842 mt (420,624 st). In contrast the PM sector, representing 92% of the iron powder market, increased by less than 1% to 351,285 mt (386,963 st). However, the non-PM sectors such as welding electrodes, cutting, scarfing, lancing, and miscellaneous applications all declined.
Other powder estimates reveal a similar pattern. Stainless steel powder shipments rose by 4.9% to 7,625 mt (8,400 st). Nickel powder shipments also rose, but by a negligible amount to 5,628 mt (6,200 st). Copper powder shipments slipped marginally to 16,158 mt (17,800 st). Non-PM copper powder applications such as bio-medical and brazing performed better than traditional PM.

While aluminum PM offers significant growth, especially in the automotive market, the total aluminum powder market fell by 12.5% to 31,773 mt (35,000 st) in 2016. The loss of a major end-user switching from aluminum powder to another technology to produce polysilicon receives the blame for this sharp drop off. The current annual U.S. aluminum PM parts market ranges from 1,815 mt to 2,723 mt (2,000–3,000 st).

The refractory metals market declined again, due to a protracted slowdown in the oil-and-gas markets. Tungsten powder shipments declined an estimated 56% to 1,152 mt (1,270 st); however, tungsten carbide powder shipments increased an estimated 23% to 5,234 mt (5,770 st). Molybdenum shipments remained stable at an estimated 1,760 mt (1,940 st).

Total estimated 2016 North American metal powder shipments decreased modestly to 450,873 mt (497,104 st).

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<thead>
<tr>
<th>North American Metal Powder Shipments</th>
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<tr>
<td>2015</td>
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<tr>
<td>Iron &amp; Steel</td>
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<td>Stainless Steel</td>
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<td>Copper &amp; Copper Base/Tin*</td>
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Based on industry conditions during the past several years, it appears that traditional PM markets have stabilized or reverted to a slower growth pattern. Putting these 2016 numbers in perspective can be somewhat sobering. For example, iron powder shipments in 2006 were 378,396 mt (416,828 st) when the automotive market accounted for the production of 15.3 million light vehicles.

The current situation calls for the industry to focus more than ever on seeking new markets and applications, and renewed R&D funding.
PM Parts Market Trends
Overall, 2016 can be characterized as an encouraging business year for the industry’s leading sector. PM parts makers experienced steady gains, especially among suppliers of higher value-added automotive parts. Industry sales gained by an estimated range of 4%–10%, depending upon markets served.

The 2017 MPIF PM Industry Pulse Survey conducted among members of the Powder Metallurgy Parts Association (PMPA) during the fall of 2016 revealed: iron-based parts represented 82% of product shipped, followed by stainless steel parts at 9%, copper-based parts at 6%, soft magnetic parts at 2%, and aluminum at 1%.

Most PMPA respondents (79%) did not see an increase in their customers’ purchase of imported PM parts vs. domestically produced parts. In addition, 69% of respondents have experienced a re-shoring or re-sourcing of product returning to the U.S. from foreign sources. As an example, a long-standing privately owned parts maker reported a major customer re-shoring parts made in China. Delivery problems that required a massive inventory of Chinese-made parts forced the change. In addition, the U.S.-made PM parts were still competitive with China.

Companies based in PM’s heartland, Western Pennsylvania, enjoyed positive business levels across the board. The many family-owned job shops offer rapid-response service to customer needs, quick decision-making, and short-run production.

Automotive Market Trends
While different experts point to U.S. auto sales peaking and contracting this year to about 17 million to 17.2 million light vehicles, the short-term outlook for PM parts sales remains relatively stable and positive. The reasons include: new applications; new product launches and more value-added production steps such as automatic inspection; more overall automation; and relying more on grinding, turning, and milling for closer tolerances.

The best-selling light trucks with V-8 engines and SUVs continue their normal PM parts content of up to 27 kg (60 lb.) or more. Crossover vehicles carry an estimated 20.2 kg (45 lb.) of PM parts, and passenger cars contain about 10.8 kg (24 lb.) on average.

GM and Chrysler vehicles still use six-speed transmissions that contain an estimated 10.3–12.1 kg (23–27 lb.) of PM parts. Newer eight and nine-speed transmissions account for the same or fewer pounds. Variable valve timing (VVT) systems, using up to 2.7 kg (6 lb.) of PM parts in larger engines, will continue to grow.
Recent trends include new applications in automotive electric power trains, the development of more complicated gearing, and new wear coatings on moving parts. Aluminum PM parts will see strong gains as automotive designers strive to reduce vehicle weight. A new and exciting PM aluminum transmission part is set to go into production this year.

Many experts see the average PM parts content in light vehicles gradually shrinking every year as smaller engines and transmissions are designed. Some of the newer vehicles will contain 2.7–3.6 fewer kilograms (6–8 lb.). Looking ahead, production in North America and Europe will stabilize while Asia (mainly China) will grow long term. For example, China produced 25.2 million light vehicles in 2016. This year Chinese production is projected to rise to 26.8 million vehicles.

**PM Equipment Trends**

According to the 2017 MPIF Pulse Survey among members of the Powder Metallurgy Equipment Association (PMEA), the majority of equipment builders forecast a stable capital equipment purchase trend over the next five years. Currently, the PM parts industry has enough production capacity in place. Most new equipment purchases are for capability as opposed to capacity. The new normal for compacting press orders annually seems to stay in the 20–25 unit range. There is a definite need for larger tonnage presses featuring more levels. For example, a Midwestern parts maker is adding a press for capability with three upper-motions and four lower-motions that is CNC controlled for specific levels. The company is also adding collaborative robots featuring articulating arms for loading compacting presses and furnaces.

Tooling trends cover more complex tooling for larger parts and innovative gear forms with teeth on the outer perimeter of parts and asymmetric sprockets. Furnace trends include rapid cooling systems and adding more zones in furnaces.

**Metal Injection Molding (MIM) Trends**

U.S. metal injection molding (MIM) sales increased by about 10% in 2016 to an estimated range of $350 million to $400 million. The industry includes about 25–30 commercial job-shop parts makers and 15–18 captive operations making medical & dental and firearms for their own products. It is estimated that MIM-grade powders consumed in the U.S. increased by at least 10% to a range of 1,365,000–1,745,700 kg (3–3.85 million lb.).

Stainless steels and low-alloy steel continue dominating the MIM materials mix, representing an estimated 83% of powders consumed. Other MIM materials include soft magnetic materials, tungsten alloys, titanium, tool steels, Inconel 625 and 718, and tungsten carbide.
Traditional MIM markets remain steady, except for a significant decline in the firearms market beginning in early 2017. MPIF’s Pulse Survey among members of the metal injection molding association (MIMA) show the market breakdown of North American MIM parts shipped by weight in 2016.

![2016 North American MIM Market (by weight)](image)

Source: MIMA 2017 Industry Pulse Survey

**Metal Additive Manufacturing (AM)**

The PM industry’s newest family member, metal additive manufacturing (AM), is on the move and showing great promise. Industry observers draw parallels to the formative years of MIM, but metal AM has many more major international corporations, investor groups, and universities making serious dollar and R&D-time investments in the technology. It seems that just about every metal powder company seeks to carve out a stake in the metal AM marketplace as a supplier. Leading powder materials still include 316 and 17-4 PH stainless steel, cobalt-chrome, and titanium. Companies are also investigating aluminum alloys, copper, super alloys, platinum, Inconel, tungsten, molybdenum, and tool steels.

Despite all the fanfare, true commercial long-run production still revolves around only three product classes: titanium medical implants, cobalt-chrome dental copings, and cobalt-chrome aircraft nozzles. Nevertheless, there are numerous job shops doing limited prototyping of short runs and developmental projects aiming at more serious commercial projects. Currently there are close to 12 metal AM equipment suppliers supplying the international market and up to 75 North American metal AM parts fabricators, including job shops and in-plant manufacturing operations.
Hot Isostatic Pressing (HIP) Trends
HIP industry companies gained in 2016 based on a pick-up of demand from the aerospace and aircraft engine (commercial and military) markets. Nevertheless, the oil-and-gas market sectors continued in a depressed mode. Densification services for MIM and metal AM parts remain strong and will continue to grow. HIP processing of high-speed steel billets will continue growing as well. According to the 2017 MPIF Pulse Survey, the macro outlook for the HIP industry remains in a growth life-cycle.

Refractory Metal Trends
The tungsten market appears to have bottomed out in 2016 and there is relief in sight, although it is precariously dependent on oil-and-gas prices, which remain low. North American oil-and-gas drilling rigs have been steadily increasing at rates not seen in six years and are at April 2015 levels. Drilling rig count is up 85% today over the same period in 2016 (885 vs. 479 rigs). Mining activity is up with some metals, but not consistently up overall, and is greatly dependent on global economies such as China, whose economy is still neutral. Meanwhile, there have been increases in mining for zinc, coal, and copper, which has had a positive effect on tungsten. Both of these well-established tungsten market applications play an important factor in the PM industry.

2017 looks to be a positive year for refractory metals as global economies continue on their positive trend, energy demand is increasing, and OPEC agreements have reduced oil production.

Technology Trends
The MPIF Technical Board is addressing important needs for 2017 and beyond to support the industry’s growth into new PM markets. It has revised the PM Industry Roadmap, last updated five years ago, with a new version released during POWDERMET2017. The Technical Board, made up of 21 industry experts representing major sectors of the PM industry, is focusing on four technology priorities: high-density PM parts, processing lightweight PM materials, improvement in precision/accuracy/variation control in components, and developing metal AM grade powders. All of these priorities offer significant promise. Other Technical Board programs include evaluating new developments for hybrid and electric vehicles, materials for extreme applications, and battery technology.

The Technical Board is also providing input to PM-related projects conducted by the Lightweight Innovations for Tomorrow (LIFT) in Detroit, one of the founding institutes in the National Network of Manufacturing. LIFT researchers are currently studying PM aluminum metal matrix composites. Additionally, programs for press-and-sinter titanium materials, rapid HIP-cycle process development, and nanocrystalline high-strength ferrous materials have been identified as possible areas of interest.
The Outlook
With signals from the national economy still flashing good news, the PM industry’s general outlook for 2017 should be satisfactory. This is especially true for the metal injection molding and metal additive manufacturing sectors. Traditional PM parts sales should still experience moderate growth in the automotive, consumer products, and industrial equipment markets.

The 2017 MPIF Pulse Survey points to continued sales increases. Overwhelmingly, PMPA members see gains. Matching their optimism, 83% of the responding companies will add to their workforce this year, and 66% will increase capital spending. Members of the Metal Powder Producers Association (MPPA) are equally divided about their sales forecast: 50% see increases while 50% see sales staying even. Meanwhile, 89% of the Metal Injection Molding Association (MIMA) respondents project sales increases. Members of the Isostatic Pressing Association’s (IPA) also expect gains in 2017.

PM companies are well-positioned to meet the challenges ahead with realistic expectations, careful planning, and R&D investments. Opportunities within the industry are plentiful. PM’s positive history of reinventing itself by adopting new technologies and entering new markets will certainly support continued growth in the years ahead.

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About the Metal Powder Industries Federation
Metal Powder Industries Federation is the North American trade association formed by the powder metallurgy industry to advance the interests of the metal powder producing and consuming industries and provides a single point of reference for all MPIF member companies.

About APMI International
APMI International is a non-profit professional society which promotes the advancement of powder metallurgy and particulate materials as a science. Its purpose is to disseminate and exchange information about PM and particulate materials through publications, conferences, and other activities of the society.

About the Center for Powder Metallurgy Technology
The Center for Powder Metallurgy Technology merges the academic and corporate powder metallurgy worlds together with a joint goal to promote PM industry progress. This progress depends on the business community and its drive for profit, and it also takes the educational community with its dedication to research and the pursuit of knowledge.