Powder Injection Molding – World Markets and Technologies

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Abstract

There is a pervasive perception, particularly from the North American PIM community and also from some of the international community as well that PIM is a small, moderately growing industry. The information gathered via interview, site visit, and electronic collection indicates that this is a false perception. The PIM variant of powder metallurgy (includes metal, ceramic and carbide manufactures) is much more prevalent on a worldwide scale than currently recognized. Also, that perception of "smallness" and "niche" promoted by much of the industry in fact slows growth. This presentation presents a different perspective on the size, strength and opportunities for this valuable manufacturing technology. Further, the analysis applies some basic insights to suggest how PIM can compete with the ever growing number of new materials, manufacturing technologies, and location economics become involved in both the technical and economic decision process.

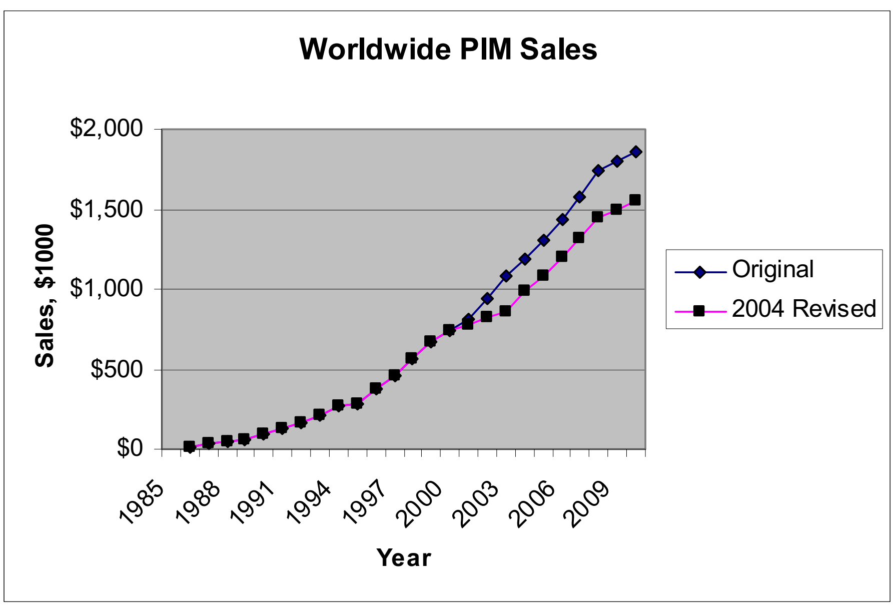
The World PIM Market

There are widely disparate estimates of the size of the worldwide powder injection molding (PIM) parts market ranging from $422,000,000 (US) and growing at a rate of about 15% as postulated by the Metal Injection Molding Association in 1992 to $750,000,000 (US) and growing at a rate of between 20 and 25% as projected by IMS in its *PIM Industry and Market Report* published in 2000. (Figure 1) This equates to roughly 70% metals, 25% ceramics, and 5% carbides based on sales income. One of the major problems is that MIMA in the fall of 2003 estimated a sales decreasing by $100 million (US) when compared to their same survey of 2002. We reject both estimates because of first a tiny sample size (MIMA represents less than 10% of the companies producing parts by PIM) and lack of rigor (voluntary submission of data). What was not stated in the MIMA statistics was the percent of the member companies that provided sales data. A variation in just this factor year to year could account for their errors. We take advantage of this opportunity to put some facts in place and to illustrate a more careful market analysis. Further, in doing so we find there is a self-diminutive character to PIM, consistently projecting a negative image of small and nonsophisticated. In reality the PIM industry is making tremendous progress and should be banding together to better educate the users and promote the technology.

As a calibration on the MIMA estimates of sales we see that similar global estimates are made in Asia and Europe. If one were to apply six sigma concepts to these sales estimates, we would find the tolerance bands need to be nearly 50% of the absolute value. For a supplier, equipment manufacture, or large multinational end-user the differences (high versus low) lead to dramatically different conclusions. A reason for the wide range in the global sales estimates comes from the originators. Most of the projections for ceramics and carbides come from the metal injection molding parts producers. In the ceramic and carbide arena the powders and markets and sintering equipment are more or less the same as used for die compaction, extrusion, tape casting, cold isostatic pressing, or other shaping . In the metallic arena, most of the PIM firms are stand-alone. Although many offer injection molded ceramics, they are not full service parts producers. For example, one ceramic PIM company of that operates at just under the $10 million per year sales range for PIM, has 28 other plants that do die compaction and other technologies. They do not belong to MIMA and consequently do not participate in the industry surveys. Thus the metallic powder molders do not accurately capture numbers for ceramics and carbide parts manufacturers. There is the further complication of not even knowing about the 35% of parts that are produced for in-house consumption. In all fairness, sales numbers are difficult to obtain because many of the companies are privately held or a division of a publicly held corporation.

In 2004, the PIM market is estimated to be just over $850,000,000 because the worldwide downturn in the economy had a negative impact on PIM sales when compared to the projections but was still up significantly when compared to other manufacturing technologies.

When examining the differences between metal and ceramic manufacturing business practices, metal manufacturers often set up one production methodology in a plant – MIM, press and sinter, casting, machining, etc., while ceramics parts manufacturers often use several processing technologies, including, pressing, tape casting, machining, and ceramic injection molding all in one manufacturing location. Example companies operating in this mode include CoorsTek, Horn, Morgan Advanced Ceramics, and Circle C. They will choose a manufacturing technology based on part geometries and production costs, not based on existing, on-hand, production capabilities. Thus it is more difficult to obtain valid numbers for ceramic and carbide PIM production.



However, it is possible to make, accurate estimations, based on publicly available company size and by simple metrics such as the number of molding machines, furnace capacity, mixing capacity, number of employees, plant size, and facility utilization factors at any PIM manufacturing facility. Another factor that significantly contributes is the production of casting cores in the United State which is a substantial industry using complicated ceramic PIM vanes that are destructively etched out to produce hollow, single crystal turbine blades, HIP shapes, or even melt filters. Indeed, this is the single largest component of PIM and contributes nearly 30% of the industry sales. Several of these operations are for in-house use, so statistics on size, sales, and other factors require serious investigations. Example companies in this arena include Alcoa, Carpenter Technology, and Precision Castparts.

Also of interest is how the per-part sales value is calculated. For instance, an orthodontic bracket made by PIM can cost 0.25 to 0.50 dollars to fabricate, sell to a distributor for $1 to $2, but can sell from $3 to $10 per piece as a final cost to the dentist. What is the appropriate value of that part when determining the size of the industry? Note that almost all of this is produced in-house at companies such as American Orthodontics, Rocky Mountain Orthodontics, Ortho Organizers, and Unitek 3M.

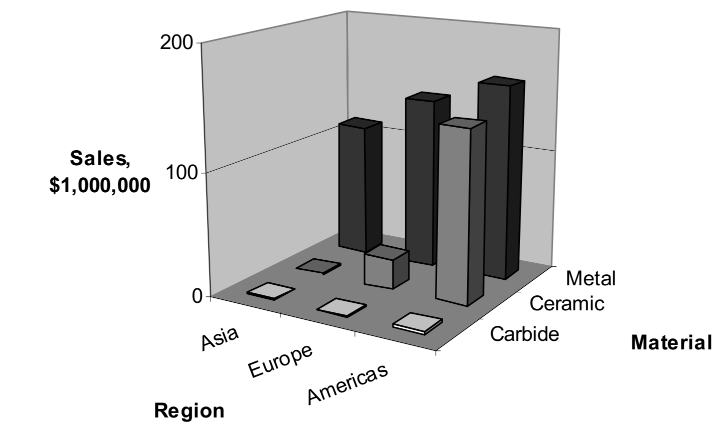
The worldwide cemented carbide industry is estimated to be more than $10 billion (US). Reports have surfaced that PIM, because of its ability to produce complex shapes, makes up about 1% (and growing) of all carbide production. Most all of the major firms in this industry run some of their products through the PIM route, but in most cases that fact is held in great confidence. One part alone sells for $14,000 per kg, making it 10% more costly after PIM than gold. The use of PIM for carbides has been growing steadily for 10 years and is now a widely distributed fabrication route practiced by firms such as SECO, Kennametal, and Multi-Metal Molding for Vermont America. Based on installed equipment, employment, and other statistics, PIM carbides could be generating as much as $100,000,000 in sales, but so far our study can only directly account for about $30 million.

Finally, one must mention the hidden parts of PIM and especially some of the very successful pockets in Asia. For example, Advanced Technology and Materials in Beijing, who employs just under 20 molding machines to produce 7 million parts per month, or Advanced Materials Technologies in Singapore which is of similar size, or some of the other hidden operations such as Shandong Jinzhu Powder Injection Manufacture Company. These companies have all started in the 1990s after the PIM technology was stabilized and just go out and make parts with little fanfare. So instead of speaking to their competitors via organizations such as MIMA, the simply focus on customers – an amazingly simple formula. But data collection and even identification of the actors requires considerable effort.

Regional Breakdown

Figure 2 gives the relative sales volume by region of the world for metal, ceramic and carbide manufacturing. In rough numbers nearly 50% of all parts sold are manufactured in the Americas with Asia and Europe dividing the remaining 50% nearly equally. Asia is coming on strong, particularly in low labor countries including China and India that are seeing aggressive growth especially in the last several years. In fact, several of the existing manufacturers from both Europe and the Americas have or are considering adding production capabilities in this region.

Figure 2 - Regional Sales by Material



Powder and Feedstock Trends

Metal and carbide powder prices will move slowly lower as increased volume purchases by feedstock manufacturers lead to economies of scale. Powder sales continue to increase, more often to the feedstock suppliers and less often to new PIM parts manufacturers. Powder producers are adding production capacity and/or are refining their processes to produce higher yields. Ceramic powder prices are not much affected. Parts manufacturers are looking to use preformulated feedstocks leading to greater part-to-part uniformity. Customers like the preformulated feedstocks because of the ability to move tooling between manufacturers and still maintain part specs without significant changes to the tooling. This helps to drive part costs down.

There are currently a handful of viable feedstock manufacturers: in Europe – BASF, Zchimmer and Scwartz, and Imeta; in the US – BASF, Advanced Metalworking Practices, and Latitude; and in Japan – BASF, Witec, and Pacific Metals Company Just last year BASF increased their available capability considerably to meet the growing worldwide demand.

Equipment Supplier Trends

There is an estimated installed equipment base of more than 1200 molding machines, 650 furnaces and 300 mixers worldwide.

Molding machines: The average annual sales per molding machine for successful companies – those running three shifts 6 days per week hovers around $1,000,000 per machine (and in a few cases approaches $2,000,000) which far exceeds the plastics average of $580,000 per machine. This can be considerably less for low volume manufacturers, especially those that only operate one shift per day. Companies with more machines have a higher average than companies with fewer machines. In key markets and special applications, it is possible to do considerably better than the average.

Furnaces: Over the last several years, there has been a small increase in the number of furnaces, both continuous and batch. Batch furnaces predominate in the industry with typical yearly sales per batch furnace at greater than $340,000 per ft^3 per year as compared with continuous furnaces that can max out at $5,000,000 per year. Companies that have both continuous and batch capabilities are better able to maximize productivity by balancing short run batch jobs with high volume parts in the continuous furnace.

Mixers: More than 50% of parts producing companies have 1 mixer. Increasingly small companies are buying preformulated feedstock for specific parts. The average sales per mixer is roughly $3,000,000 but can fall off considerably for startup and small companies.

Two other interesting metrics are the sales per employee and the sales per unit of manufacturing space. They run for terrible ($40,000 per employee per year) to superb ($255,000 per employee per year and over $650 per square foot per year). Median values put PIM far ahead of traditional powder metallurgy, so this makes PIM a more attractive option in high population areas in contrast with traditional manufacturing which tends to migrate to low population and low land cost areas.

Manufacturer's Concerns and Issues

In numerous studies, surveys and conversations with manufacturers, it is obvious that there are a number of issues, both technical and business related that affect the industry. Below are the major issues.

- Parts manufacturers are too widely dispersed, fragmented and serving too wide a variety of markets to effectively grow the technology in a big way.
- Potential customers often need to be educated as to the process and its capabilities in order to sell them parts. This is a time consuming and costly process. And the frequency of job changes often complicates this process.
- Energy costs are increasing globally leading to increased raw material, processing and transportation costs.
- There is a shortage of people skilled in the intricacies of the technology. PIM is a complex manufacturing process that requires a wide skill set.
- There is an increase in the number of parts being shopped between manufactures.
- Customers are expecting shorter lead times.
- There is a tendency for sales reps to oversell the technology and its capabilities leading to failed relationships and dissatisfied customers. This has also happened with manufacturers trying to sell larger size parts which mostly are more efficiently and economically produced by competing technologies.
- Uneven growth from small number of high volume parts
- Overseas competition from low labor rate countries.
- A consideration for parts manufacturers is to switch to manufacturing their own feedstock for major products to reduce costs.
- An inability of the industry to come together and market the technology from a cohesive perspective.

Customer Concerns

Customers have a different perspective on the industry.

- They see variability between vendors as a problem because of processing and ultimately final part differences. Because of the complexity of the process there can be major part property and dimension variations from different powder suppliers, feedstock rheologies, and processing conditions. This creates problems when customers look for multiple vendors for large orders.
- All manufacturing is concerned with quality issues. PIM is no exception.
- Repeated mistakes/learning – because the industry is so widely dispersed and there is much secrecy in PIM processing, there is a great deal of time and effort spent on

relearning what has already been known and repetition of mistakes that have already been made.
- Despite its prevalence, there are still many design engineers and buyer who have limited knowledge of the technology and its implications to their product lines.

Future Trends

New startup, shutdowns, buyouts and consolidations have and will continue to change the industry. Evidence has demonstrated that it is possible to startup a new PIM production facility for $3 - $5M (US). This includes equipment and the first 2 years of operation. For many companies and investors, this is not a large barrier. Companies contemplating this also tend to look at acquisitions to buy the existing technologies and customer base although candidates for acquisition almost always tend to overestimate their sale price.

There will be strong growth despite worldwide economic conditions because of the benefits of the technology. PIM will continue to have growth rates at between 10 and 25% over the course of the next several years as expanding opportunities in automotive and large scale industries as well as other unique applications fuel growth. Asia and European markets will grow at a faster rate but the US market will dominate because of its shear size.

Profitable companies will maximize equipment usage by operating 24/7 and use best business and manufacturing principles.

Summary

PIM is a viable technology with many opportunities to serve traditional industries as well as emerging industries. In order to be successful, parts manufacturers should consider operating in a flexible environment, should look to optimize equipment utilization and make sure that they are practicing the latest technology and manufacturing processes to optimize their potential. The future is bright for PIM.