ARMSTRONG

METAL & PLASTIC: PROTOTYPE TO LOW-VOLUME PRODUCTION

Functional Aluminium and Plastic Prototypes in 1-4 weeks

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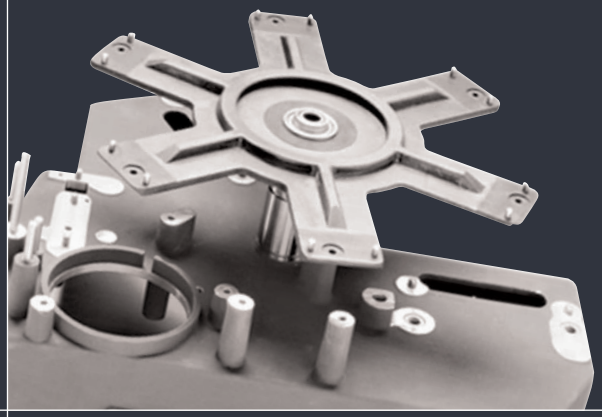
ABOUT ARMSTRONG MOLD



Armstrong Mold is a family owned business that blends old world values, craftsmanship and technology to deliver production grade metal and plastic products in both prototype and low-volume production quantities.

When John Armstrong, Armstrong Mold's founder, brought his skill and craftsmanship in plaster mold casting to the United States, he did not imagine that in 30 years the company would grow to more than 160 employees, 95,000 sq. ft. of facilities and dozens of processes for metal and plastic part production. John believes that the key to success is retaining the old world values of quality and service and blending them with the latest technology.

Today, Armstrong Mold uses the very latest in technology, including 3D CAD solid modeling, rapid prototyping and video conferencing. These tools are applied to each service that is offered to its customers:

- Rubber Plaster Molding
- Precision Airset Casting
- CNC Machining and Hogouts
- Reaction Injection Molding (RIM)
- Finishing & Assembly

While other companies offer these products, few can match the depth of experience and the breadth of services. Whether you need a single prototype or thousands of production assemblies, Armstrong Mold delivers production quality. For high precision and rapid delivery, you may find that our competitors state, "You need to talk to Armstrong Mold for that."

If you need advice on process and material for your project, or assistance to take the design and modify it for manufacturing, or a solution to delayed production tooling, count on Armstrong Mold. Call us today to get answers and find solutions.

Philosophy

Armstrong offers a complete array of prototype and short run production capabilities. With over 90,000 square feet of production space and 180 employees, we are able to deliver programs large and small on or ahead of schedule. We try to combine the best of today's technology with good old fashioned pattern-making craftsmanship and time tested manufacturing processes. Our communication and problem solving capabilities are only exceeded by our customer service.

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ISO 9001:2000 Certified

Armstrong Mold Corporation is a one-stop resource for single sourcing an unusually complete array of in-house "fully functional" prototypes and low volume production parts and assemblies, from "one-off" up to 5,000 EAU. Complete design Assistance. Armstrong specializes in the rapid turn-around of prototypes and short-run custom engineered parts and assemblies from Aluminum, Zinc and Thermoplastic production materials for your design development, rapid market entry and low volume production requirements. Turnkey and value added assemblies welcomed.

- Rubber Plaster Molding (RPM)
- Graphite Mold Die Casting
- Precision Air-Set Casting
- Reaction Injection Molding (RIM)
- Rapid Injection Molding utilizing economical cast dies
- Finishing and Assembly
- Custom Packaging
- Design Assistance
- 27 CNC Machining Centers
- Kirksite Cast Tooling for Injection Molding Thermoplastics
- RTV (Cast Urethanes)

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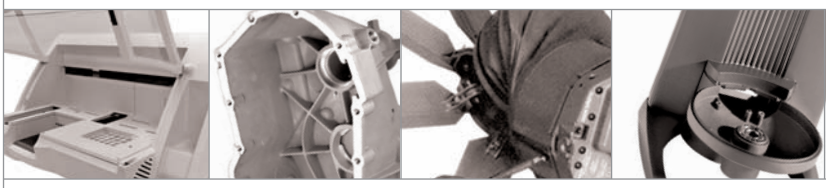

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GRAPHITE MOLD DIECASTING

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ALUMINUM GRAPHITE DIE CAST (GMDC) PARTS IN A380 & A356

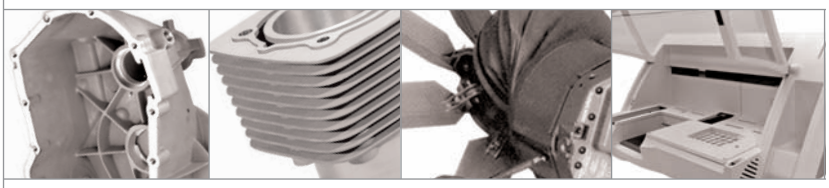
What is Graphite Mold Die Casting?

Casting molds are machined from graphite blocks into which molten Zinc is gravity die cast. Armstrong Mold is the first and only U.S. producer pouring Aluminum in graphite molds. Armstrong is now moving ahead in the development of pouring Magnesium in graphite molds.

Graphite tooling is produced at a fraction of the cost and lead-time of highpressure die-casting tools, thus reducing capital risk during the product design and performance confirmation phases of a new program. Graphite Die Cast parts can have the same properties as those made by high-pressure die casting and can be used not only for the prototype and development process, but for lowvolume production parts as well. Graphite Die Cast parts can have thin walls, tight tolerances, and an excellent surface finish for aesthetic applications.

Tooling for Graphite Mold Die Casting

- GMDC utilizes an alternative mold material, produced on CNC machines directly from CAD data, providing a new level of casting performance
- Graphite is easy and fast to machine, resulting in short lead times, low cost and readily modifiable tooling
- CNC cavity detail delivers production high-pressure die cast tolerances and repeatability at a fraction of the cost
- The excellent thermal properties of Graphite facilitate rapid solidification which ensures excellent mechanical and physical properties and cell structure
- Enables processing of 380 – 390 Die Cast Aluminum alloys, with production rates in excess of 50 to 100 castings per day
- Tooling is produced in days to weeks – not months
- Provides the capability of supporting bridge to production needs and "back-up" tooling
- Process Controls in place for fully automated molds, with pneumatic slides and ejection systems, mold temp, cycle time, and metal temp
- A rule of thumb for Graphite tooling cost is 25%-30% that of high-pressure die cast tools, while the piece price is about five times that of highpressure die cast parts, when run in much higher minimum volumes
- The life of the GMDC mold is shorter than that of pressure die-casting GMDC mold is polished after machining GMDC Aluminum Chassis – Medical Device to obtain fine surface finish on



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GRAPHITE MOLD DIECASTING

Functional Aluminium and Plastic Prototypes in 1-4 weeks

What materials are used in Graphite Mold Die Casting?

Alloys: Aluminum and zinc alloys common to high-pressure die-cast:

- Aluminum: 356, 380 and 390 (Armstrong Mold only)
- Coming Soon from Armstrong Mold: Magnesium AZ9ID-F
- Zinc (Zamac): ZA-3, ZA-8, ZA-12

ADVANTAGES OF Graphite Mold Die Casting:

- Good economics for low-volume Aluminum, Zinc and Magnesium castings
- Much lower up-front capital investment for tooling
- Excellent for aesthetic applications where appearance is very important
- Significantly reduced "time to market" on new programs
- Engineering changes easily and quickly implemented
- Low volume parts with production tolerances
- Low volume parts with the intended production mechanical properties
- Same properties as high-pressure die castings
- Very complex shapes
- Where thin walls are necessary or where weight is critical
- Graphite tools can be used as production back-up insurance to fill the supply gap in the event hard dies are lost, damaged or delayed
- Process Control: fully automated molds with pneumatic slides and ejection system, mold temp, cycle time, and metal temperature
- Early fixture development for assembly and further processing operations, ahead of tools for aggressive product launch schedules
- Reduced RM waste and machining time Contact me for a quick design and manufacturability

Design & Technical Information Overview

Size Envelope: 36 x 36 x 6 inches

Surface finish: 63 to 90 RMS

Wall thickness: Depending upon geometry, a .120" nominal wall is standard with walls as thin as .090" possible in some areas

General tolerances: +/- 0.005 inch plus 0.0015 in./inch. Across parting line, add +/- 0.005"

Slide Areas: Additional tolerances are required on slide pulls, based on projected areas of slide. Up to 5 square inches add +/- 0.005 inch, up to 20 square inches add an additional +/- 0.007

Flatness and Straightness: As cast +/- 0.005 inch first square inch. Add +/- 0.003 inch for each inch thereafter

Radii Min Requirement: .015"

Holes: Min hole size "as cast" is .125"

Draft: Typical requirement is 1 degree, same as die cast parts

Angles: Standard is +/- .5 degrees

Delivery: Typically, 3 - 5 weeks for tooling, 30 to 100 pieces cast per day

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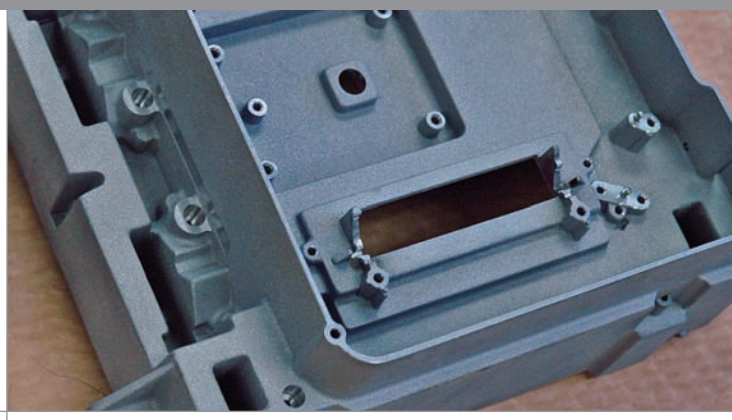
PRECISION AIR-SET SAND CASTING PROCESS



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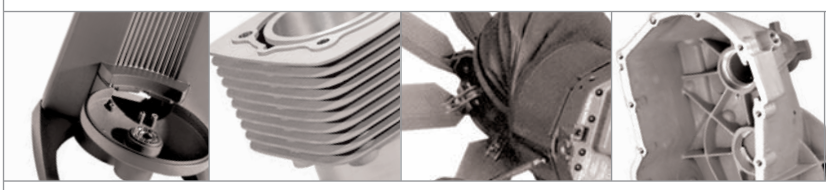
Armstrong utilizes the no-bake sand molding process. This produces metallurgical quality and finish that is superior to that of industry standard oil or green sand methods.We utilize only much finer grain silica than most foundries, taking this extra step toproduce a better finished casting.

Another reason we produce castings more precise than others, even those who use this process, is the engineering work we put into the pattern before making the molds, and the checks and processes to which we subject the casting after it is poured. These steps include:

- The initial design of the datum points and parting of the mold is selected for ease of machining and to achieve dimensional quality.
- The mold material used (cores of no-bake sand, shell sand or plaster) and gating is created to give the customer the best metallurgical quality and the best surface finish achievable.
- Required fixturing is designed to insure dimensional quality through the straightening and final inspection process.

On the shop floor, the tests that are done on the melt before it is poured are:

- A spectrometer check that will give us a chemical analysis to confirm the alloy is within specification.
- An Alu-delta check, giving us the grain size and the silicon eutectic phase of themelt. Both the grain size and eutectic phase can be adjusted with additions to the melt.
- Purging the melt with an inert gas to drive off the hydrogen level of the melt, to finely control porosity in the casting.
- Test bars are poured from the melt and follow the casting through heat treatment to check tensile strength, yield point, and percent of elongation.
- When required, a sample of the melt is polished and a metallographic inspection is performed under microscope, checking grain structure and the silicone phase



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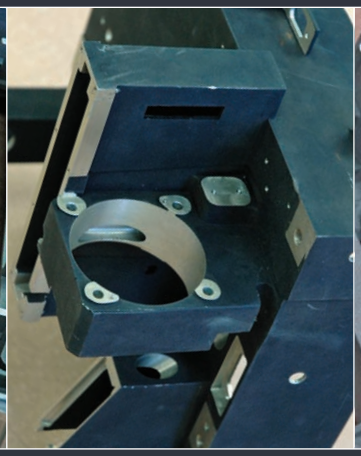
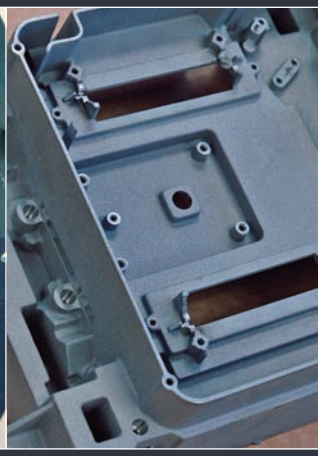
PRECISION AIR-SET SAND CASTING PROCESS

Functional Aluminium and Plastic Prototypes in 1-4 weeks

After the casting is poured and goes through knockout, the new casting:

- Undergoes First inspection.
- Is serialized.
- Is x-rayed to prove internal integrity, the gating system design, as well as to check for melt temperature problems, porosity and internal flaws.
- Is processed to improve the finish quality.
- Goes through the straightening department. In straightening, the casting will be put through a solution cycle of 1000 degrees F for 12 hours (time and temperature dependent upon the alloy) which puts them in a T-4 or soft state for several hours. During this time the castings are straightened to templates and fixtures to confirm dimensions critical to function are obtained, the machined surfaces are properly located and the geometry is correct.
- Put through an aging heat treatment cycle of 310 degrees for 3 to 5 hours (depending on alloy) which hardens the casting to a T-6 state to improve the machined surface.
- Goes through a final inspection process to check DTF dimensions and to make sure that all steps in the process have been completed.
- Where required and for additional cost, the casting can also be put through pressure testing, dye-penetrant testing and a final x-ray, Foundries that skip some of these critical steps may be able to make a casting cheaply. However, they will not be certain of the metallurgical quality, internal integrity or dimension stability of that casting let alone be able to provide traceable information.





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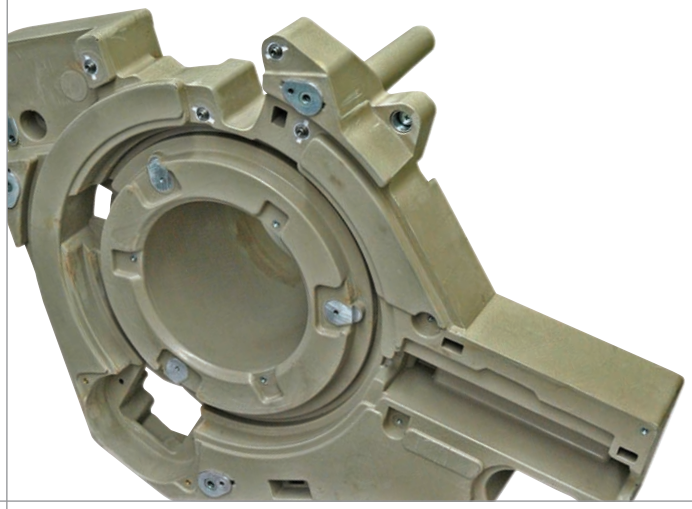
RIM REACTION INJECTION MOLDING



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Multiple Part Assemblies, Large Complex Shapes Structural and Aesthetic Pleasing Curved Surfaces

What is RIM?

Polyurethane reaction injection molding (RIM) technology was developed in the late 1960s. Like thermoplastic injection molding, RIM is a plastics-forming process that uses molds to form parts.

However, the similarity ends there. It is helpful to view RIM not as a specific resin with narrowly defined properties, but as a process capable of achieving a broad range of properties. As its name implies, the polyurethane RIM process uses polyurethanes to produce molded parts. The polyurethanes begin as two liquid components, compared with the pellet form of most thermoplastics.

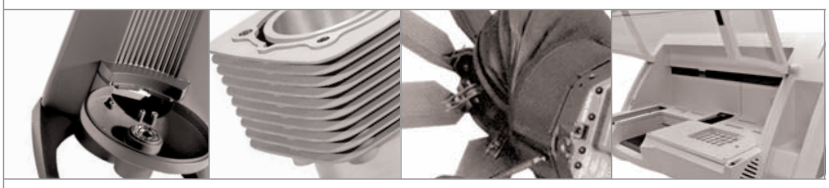
These liquid components - an isocyanate and a polyol - are developed in two-part formulations, which are often called polyurethane RIM systems.

Inserts Rim Overmold – Metal Casting Multi-Densities

Curvaceous Encapsulated Multi-Densities Weather Sealed Very Large

Depending on how the polyurethane RIM system is formulated, the parts molded with it can be a foam or a solid, and they can vary from flexible to extremely rigid. Thus, polyurethane RIM processing can produce virtually anything from a very flexible foam-core part to a rigid solid part. Part density can vary widely, too, with specific gravities ranging from 0.2 to 1.6.

Molds can be resin, spray metal, cast aluminum or machined aluminum.
Very Complex Shapes with Multiple Inserts – Low Volumes



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RIM REACTION INJECTION MOLDING

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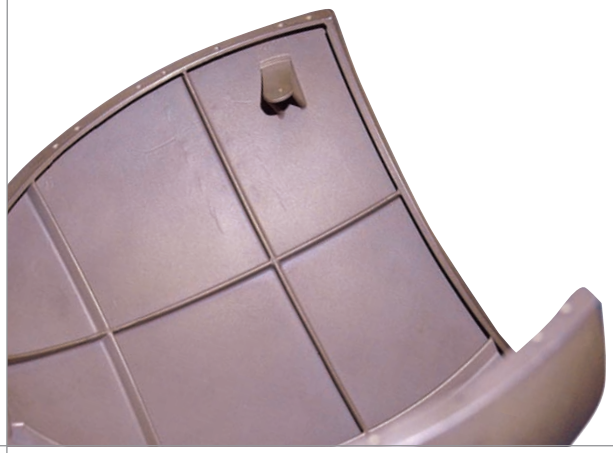
RPMC RUBBER PLASTER MOLD CASTING



What is RPMC?

Rubber Plaster Molding is a method of producing aluminum or zinc castings by pouring liquid metal into plaster (gypsum) molds.

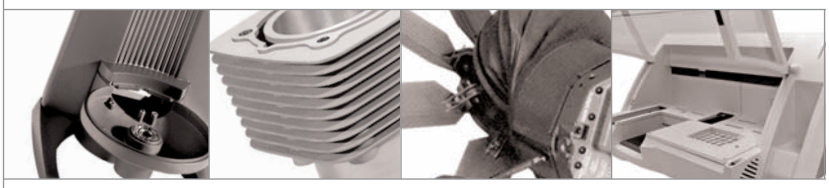
Rubber Plaster Molding is extremely versatile, and is capable of prototyping parts that are more typically produced using die-casting, permanent-mold, investment casting or sand casting methods. Plaster Casting is excellent for rapid prototyping and short-run production. Die-cast surface finish and thin walled geometry are easily produced using plaster casting. The tooling used in the plaster casting process has the ability to release
molds with undercuts or features with zero draft. Tooling can be inexpensively modified when compared to die-cast or investment cast tools for aluminum and zinc alloys

How Does RPMC Work?

Step 1: Model or Master Pattern (positive)
Step 2: Rubber Mold Pattern (negative)
Step 3: Resin Mold Pattern (positive)
Step 4: Plaster Mold (negative)
Step 5: Metal Pouring (positive)
Step 6: Break-Out and Clean-Up:
Step 7: Secondary Operations

When should RPMC be considered?

- Low cost tooling is required to produce precision, highly complex shapes, and premium quality aluminum and zinc castings.
- Good surface finish is required.
- Dimensional accuracy is required.
- Rapid prototyping for die-cast parts to reduce time to market and U.L. approval.
- Economical short-run production (1-2000 pieces up to 5,000)
- High volume applications of complex or unusual shapes. (as compared with CNC)
- For aesthetic applications where appearance is critical.
- Bridge tooling for long lead-time production die cast & as backup tooling.
- Require geometry with zero draft.
- Wall thickness less than .040"/1.01mm.
- Minimal residual stresses and distortion in castings.
- Reduce time for machining and secondary operations.



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RPMC RUBBER PLASTER MOLD CASTING

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Functional Aluminium and Plastic Prototypes in 1-4 weeks

RPMC Technical References

Alloys: All aluminum, zinc casting alloys to commercial and military specifications.

Size: There is no size limitation but parts typically range within 2 Cu In. to 36 cu. in. and range in weight from 1 oz to 15 lb.

Wall thickness

Thin wall: 0.030" -.060"

Average: 0.080 " - 0.120"

Thick wall: 0.180" - .500"

General tolerances

0 in. - 2 in. +/- 0.010 in.
2 in. - 3 in. +/- 0.012 in.
3 in. - 6 in. +/- 0.015 in.
6 in. - 12 in. +/- 0.020 in.
12 in. - 18 in. +/- 0.030 in.
18 in. - 30 in. +/- 0.040 in.

Limitations: The process is limited to non-ferrous metals with pouring temperatures below 2,000 °F - including aluminum, zinc, magnesium and some copper-based alloys.

Holes: Not economical to cast small holes (1/4 in. or less) unless odd shape or inaccessible areas for machining.

Draft: Typically 1/2 to 2 degrees. Zero draft is possible in specified areas.

Corner radii and fillets: As required, typically 1/16 in.

Mechanical properties: Tensile, yield & elongation per the appropriate commercial and military specifications.

Tooling - pattern equipment:

- Loose pattern, to expedite for up to 20 pieces.
- Epoxy resin, usually up to 500 pieces.
- Metal, aluminum or brass, used to obtain best tolerance and quality.
- Rubber for quantities up to 1,000 pieces. Tooling can be duplicated easily from master tooling to expedite delivery or for higher volumes.

RPMC Cost

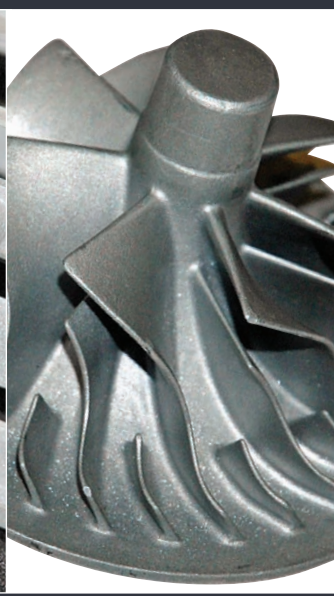
Rule of thumb for complex shapes within a 15 in. cube:

- RPMC tooling is 10% of die cast tools.
- RPMC part unit price is 10 x die cast.

RPMC Typical Applications

1. Framework, cases, shells, enclosures, bases, housings, for telecommunications, business machines, medical equipment, computers, automotive, aerospace, electronics and robotics.
2. Molds for plastics industry - rotational molds, vacuum form, expanded polystyrene molds, kirksite injection molds.

Rubber / Plaster Mold Casting
Aluminum or Zinc Castings



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