Graphicast INC.

CASE STUDY

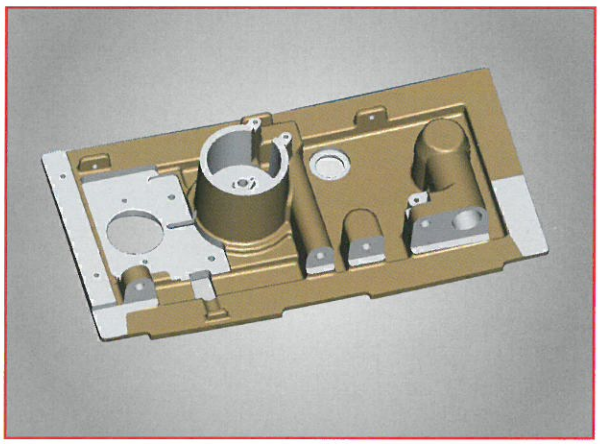
ZA-12 Alloy Casting with Graphite Molds: Economical Precision Parts, Reduced Time-to-Market

Always a major consideration, time-to-market has become even more important for manufacturers in today's economy. Whether foreign or domestic, the competition is fierce. And in many fields, rapid technological advances can make a product obsolete in a matter of months. In the production of equipment for communications, health care, scientific research, and countless industrial processes, development time can make the difference between a contract won or lost.

Because the parts that go into such equipment must be ready on schedule, more and more manufacturers are investigating an economical yet often overlooked casting process that can provide rapid turnaround, especially for production runs of 300 to 20,000 parts.

Dramatically Shorter Time-To-Market

This process makes use of graphite molds to produce parts from ZA-12, a zinc-aluminum alloy (approximately 11% aluminum) that is harder, stronger, and more durable than aluminum, brass, bronze, or plastic. With an experienced supplier that offers single-source production capabilities including in-house design, rapid 3-D printing or SLA prototyping to accelerate the customer's part design, tooling and mold production, casting, and machining, typical turnaround time from finished CAD design to first article samples is only four to six weeks.

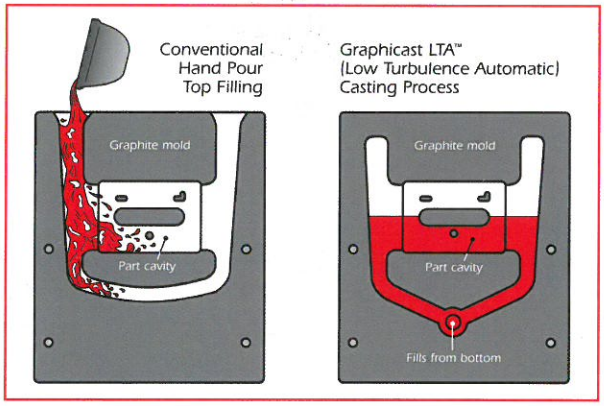


The ZA-12/graphite mold process begins with a computer-generated image of the desired part. This image of a part for a medical diagnostic device was created with 3-D solid-modeling CAD software.

In a typical medium-volume production run, the cost to machine each part from scratch is too high, yet the quantity is too low for high-volume casting methods to be cost-effective. Based on total acquisition cost (cost-per-part times volume plus tooling costs), the permanent graphite mold/ZA-12 casting process is an economical alternative to CNC machining, die casting, sand casting, and investment casting. Furthermore, the high accuracy and lustrous surface finish of ZA-12 parts virtually eliminate additional finishing steps required with other casting techniques, further reducing overall production times and costs.

Tooling in Less Time and at Lower Cost

Tooling costs for the graphite mold/ZA-12 process are much lower than for die casting or injection molding. Graphite costs much less than tool steel and requires no heat treating. Its exceptional machinability dramatically shortens the moldmaking phase. In fact, a graphite mold often takes weeks less to produce than a die-casting mold and can be produced for about one-fifth the cost.



Specially designed equipment such as the Low Turbulence Automatic™ casting machine (right) can control fill rate, cycle time, and temperature simultaneously. Because they fill each mold from the bottom, these machines minimize the turbulence of the molten metal, producing parts of exceptional quality and repeatability.

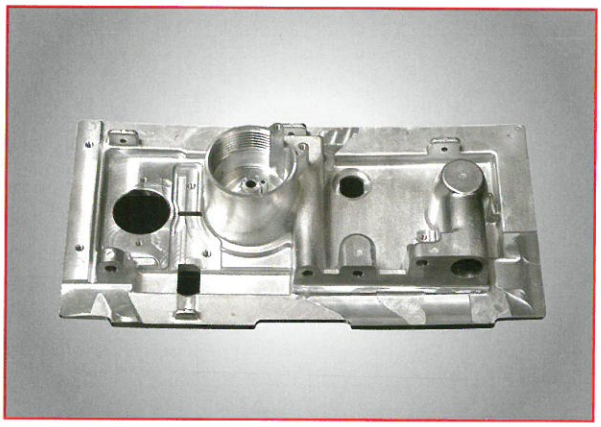
Compared with typical sand casting and investment casting processes, the graphite mold/ZA-12 process yields parts with accuracies and surface finishes as good or better at a much lower cost per part. And, unlike sand casting and investment casting processes, in which molds are destroyed when the castings are extracted, graphite molds are permanent and reusable.

The properties of graphite, a form of carbon, make it ideal for moldmaking. The overall stability (it has a coefficient of expansion lower than steel) and very low porosity of graphite allow molds made from it to hold shape when filled with molten metal. Graphite does not conduct heat as well as steel, so hardening time is slightly longer than in die casting, but this is more than offset by the exceptional surface finishes and ease with which castings can be machined.

As with the hardened tool steel used for die-casting molds, a graphite mold is machined in two halves and used continually. Best casting results are obtained using the latest semi-automated machines, which fill each mold from the bottom, minimizing the turbulence of molten metal within the mold. By simultaneously controlling fill rate, cycle time, and temperature with a process controller, these machines maximize the density and minimize the porosity of the castings, yielding ZA-12 parts of exceptional quality and repeatability. Under the right conditions, a graphite mold can cast as many as 40,000 parts. Casting release agents, which can spoil a part's surface finish, are not needed if the mold design has adequate draft (normally 2°) on every surface perpendicular to the parting plane.

ZA-12: Easy to Cast, Easy to Machine

Equally important to the process are the attributes of the ZA-12 alloy. Its density is approximately the same as that of cast iron, it has excellent castability, and its low casting temperature prolongs the life of the mold. Zinc is also readily available at relatively stable prices, ensuring the long-term viability of products designed with ZA-12 components. ZA-12 is spark-proof, so it can be used in hazardous environments, and it cannot be magnetized, making it ideal for electronic shielding.



Cast parts have a bright, corrosion-resistant finish and require no heat treating (top). If desired, parts can be chromated, plated, painted, powder-coated, or finished with electro-coated acrylic or epoxy (bottom).

Typically, ZA-12 castings can be produced in volume with critical-dimension tolerances of ±.003" per inch for the first inch and ±.001" per inch for additional inches. Parts require no heat treating, and surface finishes are typically better than 125 microinches (as good or better than investment- or die-cast parts). Parts have a bright, corrosion-resistant finish that requires no coating or other preparation, but if desired, they can be chromated, plated, painted, powder-coated, or finished with electro-coated acrylic or epoxy to simulate anodized aluminum.

ZA-12 is machined as easily as brass or bronze and more easily than cast iron or aluminum. In many cases, ZA-12 parts require little or no secondary machining. For those that do require boring, drilling, tapping, etc., there are graphite/ZA-12 casting houses that offer high-precision CNC machining under the same roof. Having personnel experienced with ZA-12 perform this work in-house on dedicated machining centers maximizes repeatability while minimizing costs.

A Sensible Manufacturing Approach in Uncertain Times

As mentioned previously, a graphite mold can be created quickly and at relatively low cost — a major advantage over die casting. By the same token, an existing graphite mold can be easily modified. Obviously, this affords manufacturers a much higher degree of flexibility in debugging or improving products and controlling costs than traditional casting methods.

These days, parts are often redesigned after a short initial production run. In effect, the initial run produces a lot of very expensive prototypes.

Why so many design changes? Reasons vary. Perhaps the new end product that the part went into did not perform as expected, or a competitor introduced a product with enhanced technology or lower cost, or the engineers simply found a better way to build the device. Perhaps the impetus for the redesign was not functional, but utilitarian, ergonomic, or cosmetic. Obviously, a decision to redesign a product often requires that its parts be redesigned. For example, a smaller device requires smaller parts; smaller parts require smaller molds.

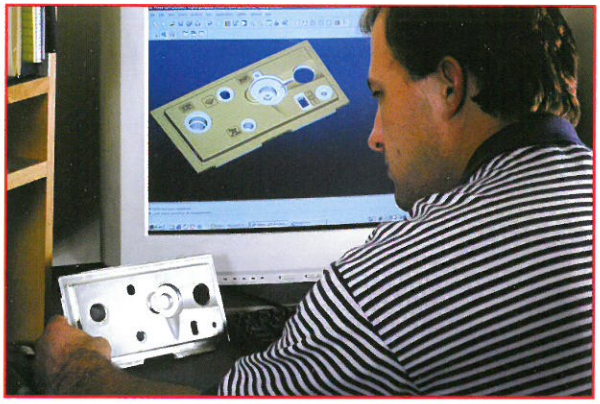
Even some customers who anticipate high-volume production of a part often realize that if the part is redesigned for any reason, a high-volume process such as die casting no longer makes financial sense. Because a graphite mold is quickly and economically created and modified, less is at stake. So, the graphite/ZA-12 process enables a customer, whether an equipment manufacturer or a parts vendor, to stay flexible. And, if end-product sales fall below expectations, the choice to use ZA-12 components can minimize costs compared with a heavy investment in a steel die-casting mold. Thus the graphite/ZA-12 process can be a hedge against uncertainty.

The Devil Is in the Details

If you've read this far, you may already be convinced that the graphite/ZA-12 process is worth looking into for your component needs. However, to help you maximize quality and minimize time-to-market, there are several other things you should consider.

Most ZA-12 parts need little or no secondary machining. However, when necessary a shop with high-speed CNC machining capabilities can quickly and economically perform boring, drilling, or tapping operations.

For example, any graphite/ZA-12 contract manufacturer that boasts of a rapid manufacturing capability should offer early and comprehensive design assistance. State-of-the-art software such as Pro/ENGINEER and Solidworks® parametric and associative 3-D solid modeling CAD programs facilitate any design modifications that might need to be made later in the process.



Design changes are made quickly and easily on the CAD system.

Advanced 3-D printing technology that produces a plaster model of the part in a matter of hours will facilitate design and debugging. This process can produce multiple copies quickly and effortlessly, allowing the model to be reviewed by different individuals in the customer's company. Sections of a model can be color-coded to indicate where design modifications (draft, radii, etc.) are needed to accommodate the casting process. Such models and accompanying notes are invaluable for resolving design problems prior to moldmaking.

Any design changes that result from a review of the plaster models can be made quickly and easily on the CAD system. Additional models can be produced overnight to verify that all changes have been made. When the ZA-12 caster receives a green light from the customer, moldmaking begins. Because they generate machine tool "G" code, Pro/MANUFACTURING™ or other CAM software packages dramatically shorten the mold machining process.

When graphite molds are completed, many shops cast 50 to 100 sample parts, and then halt production temporarily pending customer approval. Some casting houses offer waived-sample programs, which allow the customer to save more time and money by waiving the approval of cast samples in favor of uninterrupted production.

Once the design is finalized, the graphite mold should be guaranteed for the length of the production run. If mold repair or replacement is necessary, many casting houses require that the customer bear the expense. However, some casters demonstrate confidence in the quality and durability of their molds by covering any repairs or replacement costs through a one-time, up-front tooling charge. While this charge does not cover modifications to a completed mold required by a redesign of the part, such modifications can typically be made quickly and easily for a modest fee, especially if the shop has high-end CAM software.

Quality, Speed, Economy, and Flexibility

Due to unrelenting advances in technology, products tend to "mature" sooner than ever before — a nice way of saying they are nearly obsolete when they come off the assembly line. Manufacturers live with the worry that a competitor will undercut them, either with a new design or by moving production or assembly overseas where labor is dirt-cheap. Casting ZA-12 alloy with a graphite mold offers original equipment manufacturers a viable alternative to other production methods in these uncertain times. For part quantities from 300 to 20,000, the graphite mold/ZA-12 process is as precise or more precise than other casting methods at a fraction of the cost.

The ZA-12/graphite mold process also offers OEMs a hedge against expensive design modifications in a volatile marketplace. A commitment to a large die-casting run (above 20,000 parts) can mean a large up-front investment, which turns into a loss if sales fall below expectations. Why not minimize the financial risk by starting with a shorter run of ZA-12 parts? If the part/end-product is successful, follow it up with another run, and another. The graphite mold/ZA-12 process lets OEMs keep inventories low, by utilizing a Kanban or JIT system. And, with today's demands for reduced costs — both manufacturing and inventory — and shorter times to market, the graphite/ZA-12 process is an ideal way to pay as you go, quickly and economically producing high-quality metal parts.

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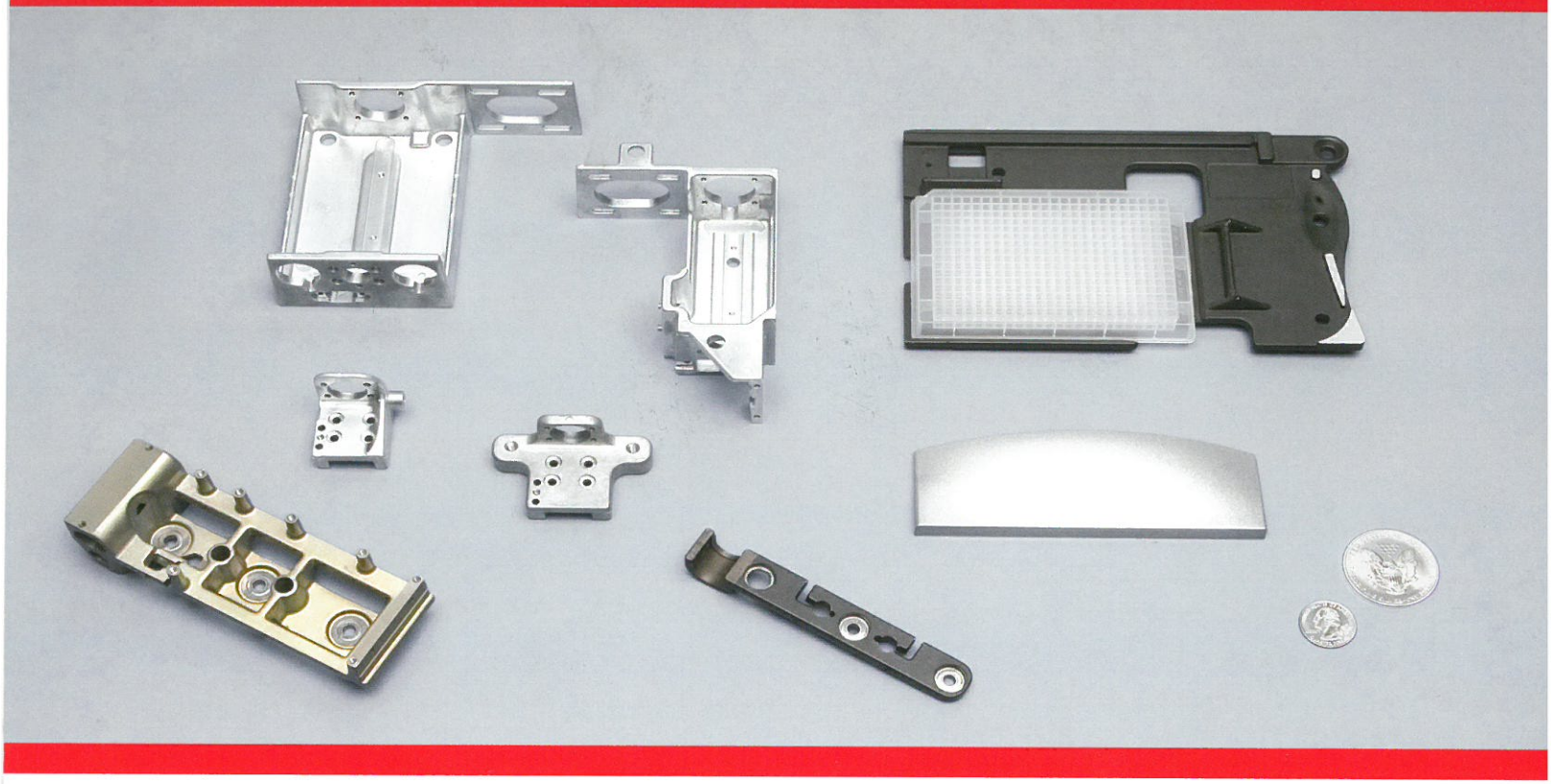
The Graphicast Advantage



- Rapid turnaround
- Lower total acquisition cost
- Ideal for production volumes of 300 to 20,000 parts per year
- Permanent graphite molds reduce mold production costs and shorten time-to-market
- ZA-12 zinc alloy is harder and stronger than aluminum, yet requires no heat treating, will not warp
- Tolerances of ± 0.005" per inch or better
- Smooth lustrous appearance requires no additional preparation or coating
- Simultaneous part and mold design using Pro/ENGINEER and SolidWorks® solid modeling CAD software
- Graphite mold production and maintenance
- Proprietary LTA filling technology yields castings of greater density, lower porosity, better surface finish, and more consistent dimensions
- Secondary machining capabilities
- Optional coatings include any commercial paint or powder coating system
- Light assembly involving bearings, bushings, dowel pins, springs, etc.

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