When the ZA-12 zinc-aluminum alloy is cast in a graphite mold, the result is an economical precision part with excellent surface finish.

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Casting the ZA-12 zinc-aluminum alloy (Zn-11Al-0.8Cu) in graphite molds produces parts that are harder, stronger, and more durable than those cast of aluminum, brass, bronze, or plastic. 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 the need for additional finishing, further reducing overall production times and costs. 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.

This article explains why tooling costs are lower, describes the way that graphite molds are produced, and shows how graphite has positive effects on the properties of ZA-12 cast parts.

Graphite tooling
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.

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

The properties of graphite, a form of carbon, make it ideal for moldmaking. The overall stability (it has a coefficient of expansion lower than that of steel) and very low porosity of graphite allow molds 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 in die-casting molds, a graphite mold is machined in two halves and used continuously. The best castings are produced with 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 surface finish, are not needed if the mold design has adequate draft (normally two degrees) on every surface perpendicular to the parting plane.

Properties of ZA-12
Equally important to the process are the attributes of the ZA-12 alloy. Its density is approxi-
mately 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. The alloy is spark-proof, making it suitable for service in hazardous environments, and it cannot be magnetized, making it ideal for electronic shielding.

Typically, ZA-12 castings can be produced in volume with critical-dimension tolerances of ±0.003 in./in. for the first inch, and ±0.001 in./in. for additional length. Parts require no heat treating, and surface finishes are typically better than 125 microinches, a finish that is as good or better than investment-cast or die-cast parts.

Castings have a bright, corrosion-resistant finish that requires no coating or other preparation. However, 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, or tapping, casting houses are available that offer high-precision CNC machining under the same roof.

Mold modifications

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 provides a much higher degree of flexibility in debugging or improving products and controlling costs than traditional casting methods.

Even some customers who anticipate high-volume production 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 may be quickly and economically created and modified, less is at stake, enabling customers to stay flexible.

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The production of a swivel elbow for a laboratory equipment stand provides an example of the comprehensive services available from some shops casting ZA-12 (Zn-11Al-0.8Cu) in graphite molds. For this job, Graphicast not only produced the mold and cast the parts, but also provided custom chromated steel shafts, assembled the shafts to the castings, and even designed reusable packaging to protect the finished parts in shipping and storage.

Specially designed equipment (such as GraphiCast’s Low Turbulence Automatic casting machine shown here) 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.

ZA-12 parts cast in a graphite mold have a bright, corrosion-resistant finish and require no heat treating. They can be produced in volume with tight tolerances.