Ceramic Injection Molding (CIM)

Ceradyne is a fully integrated producer of injection molded ceramic components. We provide complete manufacturing services that include design, engineering and tool making, as well as secondary operations such as machining and polishing.

Using the latest equipment and processes, Ceradyne produces small to large quantities of complex-shaped components with high performance properties. The Ceramic Injection Molding (CIM) process allows close tolerances and precision replication, producing components with outstanding physical properties such as hardness and toughness.

CIM is a combination of powder technology, injection molding know-how, and sintering science. Complex shapes are achievable in ultra-hard materials that are difficult, costly or impossible to form through traditional processes. CIM is also able to produce complex shapes that previously required extensive machining or assembly.

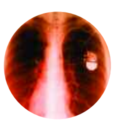
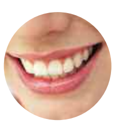
Compared to other methods, CIM offers design latitude, allowing for greater conceptual freedom and flexibility. Ceradyne has in fact pioneered a number of advances in CIM technology, including applications for implants and innovations in processing methods.

Consistent quality is assured at Ceradyne because we control the manufacturing process from raw materials to finished product.

We are certified to ISO Standard 9001:2000 and approved by many medical device companies. In addition, we maintain our own engineering department for customer interaction and assistance.

From simple to intricate designs, Ceradyne is your primary choice for strong, economical, precision-made ceramic components. Our thorough knowledge and understanding of customer requirements, comprehensive design analysis and materials selection, are the keys to well engineered ceramic components.



Applications

Surgical Devices - *Endoscopic Electrode Insulators*

Medical Precision - *Tweezers, Scissors, Blades*

Medical Components - *Cardiac Pacemakers, Implantable Defibrillators*

Dental - *Orthodontics and Dental Implants*

Electronic Packaging - *Tubes, Lids, Microwave Components*

Industrial - *Threaded Components, Wear Components, Insulators*

Ceramic Injection Molding Benefits

- Produces shapes and configurations that are very difficult to produce using conventional methods.
- Provides unique ceramic properties such as high hardness, toughness and heat/electrical resistance, depending on specific formulation.
- Eliminates the requirement to machine finished parts.
- Reduces production cost for intricate components.

Ceramic Material Properties

Ceramic material properties allow for many different engineering solutions. They are good thermal and electrical insulators, are impervious to the environment in which they function, they maintain physical properties at high temperatures and are second in hardness only to diamond. Injection molded materials include:

- Zirconia
- Alumina
- Zirconia Toughened Alumina (ZTA)
- Translucent Ceramics

The following materials are under development:

- Aluminum Nitride
- Silicon Carbide
- Silicon Nitride

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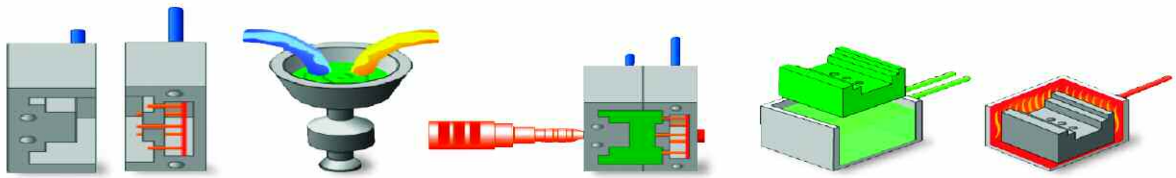
CIM Process



Tool Design and Manufacture

A key element in the success of the process is the ability to design tooling that is complimentary to both the requirements of the finished part and the potential complications of the subsequent manufacturing steps. Tool design must also consider the flow characteristics of the specific powder/binder feed stock as this parameter relates to runner design as well as gate size, positioning and configuration.

As with plastic injection molding, all tools have the requirement of parting lines, gates and ejector pins. With ceramics, mold construction must also take the shrinkage rate of the material to be molded into consideration.

Upon molding, the component has a consistency similar to a cake of soap thus the ejection system must accommodate a delicate part.

Mixing

Sub-micron size ceramic powders are mixed thermo-mechanically with a proprietary multi-component blend of binder constituents. The end result is a homogeneous blend of materials that is cooled and granulated for subsequent use as a molding feedstock.

Molding

Molding is accomplished in a standard plastic injection molding machine. The feedstock is gravity fed into the barrel of the molding machine where it is heated and moved up to the nozzle by a screw rotating in the barrel. The screw then plunges forward and rams the material through the nozzle into the cavity configured to the required shape.

When the material in the cavity cools sufficiently to hold its shape, the machine opens the tool along the parting line and ejector pins are activated to push the part out of the cavity. The machine then closes the tool and the process is repeated.

At this stage of the process, the component is referred to as a green part. It is common for these components to be produced in tools with multiple cavities thereby increasing productivity and reducing unit component cost.

Debinding

Green parts are next treated in a proprietary solvent binder extraction process. All but one of the binder ingredients are removed at this point.

The remaining binder ingredient is called the backbone and functions to hold the geometry of the green part until such time as it is sintered. This process results in a porous body that creates the pathways for the remaining binder ingredient to escape without damage to the part during the sintering process.

Sintering

The green part is then placed in one of several high temperature furnaces. The firing atmosphere required by the particular ceramic powder dictates the specific type of furnace utilized.

During sintering, the part will experience shrinkage in the order of 15% to 30% as determined by the binder system and particular ceramic powder being utilized. The fully sintered part retains the complex shape of the molded part and close dimensional tolerances can be achieved.

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Ceradyne Advanced Technical Ceramics

Ceradyne, Inc. (NASDAQ:CRDN) is a publicly traded corporation specializing in development and vertically integrated production of advanced ceramic materials at facilities based in the North America, Europe and Asia. Ceradyne's advanced ceramics are sought for the most demanding applications in automotive/engine, industrial wear, medical/dental, electronic and defense industries.

Ceralloy® components are produced in fully dedicated facilities using patented compositions and processing techniques. Plentiful raw materials are coupled with conventional, time-tested ceramic manufacturing processes that produce high quality, cost effective advanced ceramic solutions.