DYNAMIC CERAMIC
precision engineering ceramic solutions

Production Processes

The manufacturing route for advanced ceramics include:

Consolidation of the powder, green machining of the compacted powder, sintering and finally, when required diamond grinding.

Die Pressing

This is by far the most widely-used shaping technique for advanced ceramics and consists of the uniaxial compaction of a granular powder during confined compression in a die.

Isostatic Pressing

Granular powder is loaded into a flexible air-tight container, placed in a closed pressure vessel filled with liquid and compacted by increasing the pressure within the vessel. The pressure change takes place throughout the liquid, exerting a uniform applied pressure over the entire surface area of the air-tight container. In this way, the material is uniformly compacted and will retain the shape of the flexible container and any internal tooling profile.

Slip Casting

Slip casting refers to the filling of a mould (a negative of the desired shape) with a slip consisting of a suspension of micrometer size ceramic particles in liquid. The capillary action due to the pores in the mould withdraws the liquid from the slip. As the liquid filters into the mould, a cast is formed on the mould surface. Stable slips with high solids contents and low viscosities can be prepared by careful adjustments of the chemistry of the slip by adding deflocculants.

Extrusion

This forming process consists of forcing a plastic mix (containing ceramic powder) through a constricting die to produce elongated shapes with a constant cross-section. The powder mix consists of a fine ceramic powder with the appropriate additions of binder(s) and plasticiser(s) to give the desired flow properties (rheology), either cold or when heated prior to being forced through the die.

Injection Moulding

Similar to extrusion, a plastic mix is prepared and heated in the barrel of the moulding machine until at a sufficiently low viscosity to allow flow when pressure is applied. A plunger is pressed against the heated mixture, forcing it through an orifice into the tool cavity. The moulded part is removed from the die and, prior to sintering, the organic binder slowly burnt out in a controlled atmosphere, by means of a carefully controlled heating schedule.

Tape Casting

This process involves the casting of a slurry onto a flat moving carrier surface. The slurry usually consists of a ceramic powder with added solvents, plasticisers and binders.

The slurry passes beneath a knife-edge as the carrier surface advances along a supporting table. The solvents evaporate to leave a relatively dense flexible sheet that may be stored on rolls or stripped from the carrier in a continuous process.

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Green Machining

This technique is commonly applied to as-pressed parts which are still in a chalky condition. Common metalworking machines are used to machine the part in this soft condition, as greater material removal rates are possible than by post-sintering operations such as diamond grinding. As-fired green machined components are subject to tolerances of approximately ± 1%. To achieve tighter tolerances, diamond grinding must be employed.

Sintering

The compacted and machined components are fired or 'sintered' at temperatures approaching 1800ºC. During this operation, the powder particles bond together and component shrinks by 15-35%.

Hot Pressing

This forming technique combines the simultaneous application of external pressure and temperature to enhance densification. It is carried out by putting either powder or a compacted pre-form into a suitable die, typically graphite, and applying uniaxial pressure while the entire system is held at an elevated temperature e.g. 2000°C for SiC. This is only suited to relatively simple shapes.

Hot Isostatic Pressing (HIP)

This technique involves sintering a compact at high temperature in a pressurised gas atmosphere. The compact must either be impermeable to the pressurising gas or encapsulated in a gas-tight container. In the former case, powder compacts are first sintered to between 92% and 95% of theoretical density, eliminating surface connected porosity. The sintered compact is then hot-isostatically pressed, (HIPed) under inert gas pressure to theoretical density. HIP conditions are typically Argon at 200MPa and 1600°C. The pressurising gas is used as a driving force for full densification of the part.

Diamond Grinding

Following sintering, the ceramic (now in its ultra-hard state) is machined using diamond grinding techniques which, together with lapping and polishing, enable tight tolerances and smooth surface finishes to be achieved. These include dimensional tolerances of ± 1µm, with flatness values of < 1 light-band and surface finish of < 0.005 µm Ra. However, diamond grinding is relatively expensive, so if as-fired tolerances are acceptable, the overall cost of the component is reduced.

Customer Support

Dynamic-Ceramic manufactures custom-made parts to our customers' specifications. For more details of our products and services or to discuss your specific requirements, please contact one of our Sales Engineers.

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