Process Development

Process Development and Component Fabrication

The ceramica goup at Swerea IVF carries out research within various powder-shaping technologies and recently the work with prototyping has been a growing part. The choice of forming technique at manufacture of components (ceramic or metallic) depends on the size, geometrical shape, material demands, planned series size and possible cost limitations. Based on these aspects, compromises and priorities are most often required in order to reach the most balanced and optimised result. We have the competence to guide you to the right choice of method for the current application and component.

Commissioned research within the powder-shaping area can, for example, consist of the manufacture of a component in a specific material utilising a suitable shaping method. This can include design and mould fabrication, optimisation of powder suspension or granules, shaping, possible green machining and, finally, sintering and desired material evaluations. We can also assist in the set-up of production units (lines) that can include education of personnel, start-up assistance and "trouble shooting". In the following a number of processes, commonly utilised within powder-based manufacture of components, are described.

Shaping Techniques

Slip casting and direct-casting techniques

Slip casting is a common shaping method within the ceramic industry. The advantage is the possibility to shape geometrical complex components, in general to a high degree of material homogeneity. Further, the mould material, plaster, is cheap. Today, pressure slip casting is more frequently used. In this case polymeric moulds are used and an external pressure drives the filtration process. The pressure-casting process can be simulated in small scale by filter pressing experiments.

Component made by direct casting.

In recent years we have developed novel water-based, colloidal shaping techniques. These so-called direct-casting techniques are based on the transformation of powder suspensions from fluid to rigid consistency without any powder compaction or removal of water. Besides the in-door direct-casting techniques (Protein Froming and Starch Consolidation), we have has extensive experiences of other methods of the same type belonging to the family of gel casting techniques. The potential ability of these techniques to provide very high degree of homogeneity in shaped specimens gives condition for good dimension control and optimal material properties. Additionally, a large freedom regarding geometrical shape and mould material is provided. Therefore, these methods are most suitable for the manufacturing of ceramic or metallic prototypes and components in small series to limited cost.

Tape casting

At manufacture of thin tapes/layers (for example for membrane or sensors) and laminates including LTCC (Low-Temperature Co-fired Ceramics) tape casting is normally utilized. We are in possession of a tape casting machine (continuous casting with stationary casting station) for casting of various types of materials. The machine is constructed for casting of tapes with a thickness in the range of 4–400 µm. For thicker components (0.5–7 mm) lamination of green tapes can be conducted. Lamination is also used to produce composite materials where tapes with different properties can be alternated and laminated prior to sintering.

Pressing incl. Granulation

Powder pressing is a very common industrial shaping technique for manufacture of components with relatively simple geometry. Most often granulation of the powder prior to pressing is required. We have developed and used freeze granulation for many clients with considerable success. Freeze granulation has many advantages versus conventional spray drying in that free-flowing and easy crushable granules with very high degree of homogeneity can

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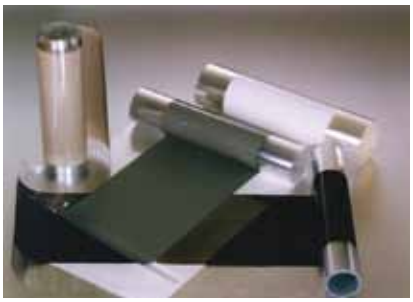

Ceramic tapes on carrier films (green tapes).

Contact persons

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Swerea IVF AB, +46 (0)31-706 60 00

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be achieved. By freeze granulation small quantities for research purposes as well as larger volumes of granules can be produced with equal properties.

We are in possession of different presses, from small manual dye presses and an isostatic press to a large hydraulic automatic press with a maximum load of 100 tons (maximum dye diameter of 160 mm). The automatic press can be used as laboratory press for single tests and as a production unit for large series. It is used for pressing of ceramics, hard metals and metallic powders. This press has also good regulation facilities that enable studies of specific sequences of the press cycle.

Injection moulding and extrusion
Injection moulding is suitable for large production series of small components, especially thin-walled. The binder system (polymer/wax and processing aids) used in injection moulding has to be developed for the specific powder used. We have the competence to develop and mix binder systems whereas injection moulding is carried out together with different partners. Regarding debinding, see separate section.

Extrusion is used to shape pipes and beams but also in forming of porous honeycombed structures for catalysers and heat exchangers. It is also possible to manufacture composite structure utilising so called co-extrusion. We can develop extrusion system and conduct extrusion of smaller components.

Rapid Prototyping
(Free Form Fabrication)
Rapid prototyping/free form fabrication is an area under strong development. This technique gives unique possibilities to tailor component design as well as material structures since the component is built up layer by layer. Utilising CAD design, computer controlled shaping and the exclusion of mould fabrication significantly reduces the time to ready component. It is also convenient and possible to rapidly carry out changes in design or internal structure of the component.

We are in possession of a rapid-prototyping equipment that enable fabrication of moulds with geometrically complex shapes. This equipment makes it also possible to build up complex material structures, for example composites or well-defined porous structures.

Debinding

In many shaping techniques, for example powder pressing, injection moulding or tape casting, temporary binders are often used. Normally, these are burned out or evaporated in a later step. We are in possession of an unique equipment that enables regulation and study of these processes. A patented method has been developed to enable removal of temporary binders under rapid but at the same time, mild conditions. In this way the time for the removal can be minimized without problems with cracks or bubble formation. Debinding can be conducted in air, hydrogen or inert atmosphere.

Sintering

A large number of furnaces, from air furnaces of various sizes (up to 1800 °C) to graphiteresistance furnaces where different atmospheres, which can be applied up to a maximum temperature of 2300 °C, are available. Additionally, here is a so called GPS furnace (Gas Pressure Sintering) where a certain over pressure can be applied at sintering (10 MPa, 2300 °C). This is of special interest for example when sintering silicon nitride with reduced amount of sintering aids.

Machining

We work with machining of green bodies as well as of sintered specimens. In some cases green machining can be used as an efficient method to produce components with specific dimension requirements. We have a CNC-regulated cutter, which can be used for such machining to desired shape.

Contact us for more information

Do not hesitate to contact us if you want to have more information or have specific questions that you want to discuss. Based on your requests and needs we can provide a quotation.
More information is provided by:

Contact	Phone	e-mail	Area
Ola Lyckfeldt	+46 (0)31-706 62 77	*ola.lyckfeldt@swerea.se*	Slip casting, direct casting and granulation
Mikael Eriksson	+46 (0)31-706 62 99	*mikael.eriksson@swerea.se*	Pressing
Karin Lindqvist	+46 (0)31-706 62 62	*karin.lindqvist@swerea.se*	Injection moulding and extrusion
Erik Adolfsson	+46 (0)31-706 62 98	*erik.adolfsson@swerea.se*	Direct casting, rapid prototyping and sintering
Martin Sjöstedt	+46 (0)31-706 62 92	*martin.sjostedt@swerea.se*	Granulation, debinding and machining
Johanna Stiernstedt	+46 (0)31-706 60 34	*johanna.stiernstedt@swerea.se*	Tape casting