



METAMATERIA

MetaMateria developed an inexpensive method for making ceramic parts with complex shapes. The “green” process uses a colloidal mixture of powders in a water-based liquid that is injected into a mold and solidified. Parts can be porous (such as membrane tubes) or dense where strength or chemical resistance is desired and they can be made from practically any mixture of powders.

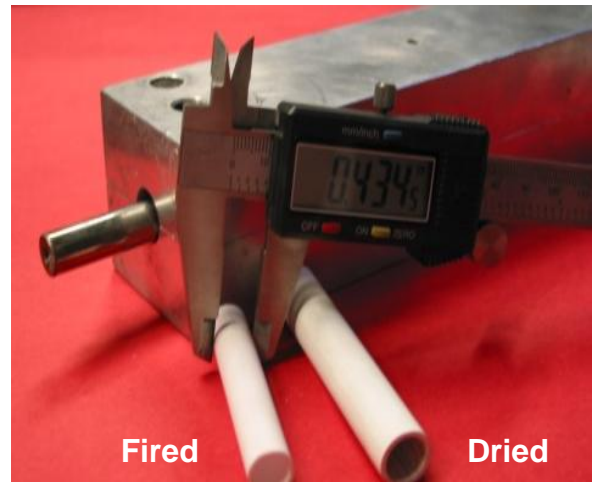
Initial applications were for fuel cell components (cathode, anode, electrolyte materials and structural parts), but is now used in many other applications. The process lends itself to automation and lower costs. Products are uniform in composition/porosity and strong enough after drying to machine additional features. Ceramic parts are then fired to obtain desired properties.

Using well-designed suspensions of powders to make parts is a critical advantage of a direct consolidation technique. High solids loading can be used, since it allows close control of part dimensions during drying and sintering. Green densities of up to 80% have been achieved with particle sizing. Shown is zirconia, with a lip inside the tube, and alumina tubes (before and after firing). A die used to make tubes is also shown.

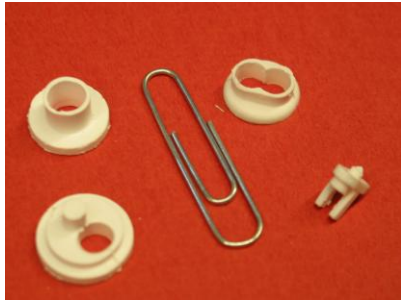
Consolidation into a solid green body is achieved without removal of water. The suspension is consolidated into a rigid body in the die without liquid removal. This is used to maintain a high degree of homogeneity, similar to that obtained in the suspension. The part solidifies in the mold (in minutes) with sufficient strength for removal. The green part is then dried and fired to temperatures appropriate for the desired density or porosity.

The process allows for controlled tailoring of porosity, which is generally interconnected. This is important whether the final parts have a high density or need controlled porosity. MetaMateria’s process is capable of producing shapes with highly specialized features. Green parts can be machined prior to sintering. This proprietary process was used to fabricate a wide range of ceramic shapes and parts from various materials, including Al_2O_3 , YSZ, WC and cathode and anode tubes/plates.

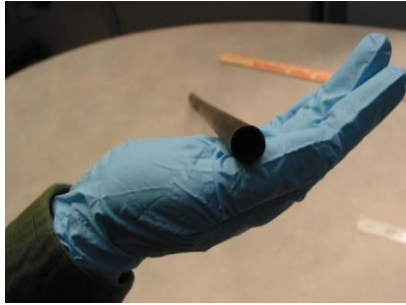
This novel ceramic forming method has several advantages over more conventional ceramic forming techniques for making parts with complex features or inexpensive production of limited quantities of parts for evaluation. Tubes can have thin walls and are very straight, compared to extrusion. It was used to make durable, high flow rate membranes for gas separation and water purification, where ceramic membranes offer considerable potential for providing high performance, durable approach for use in physical separation applications.



Examples of parts made using the MMCP method are shown below.



Detailed Alumina Parts



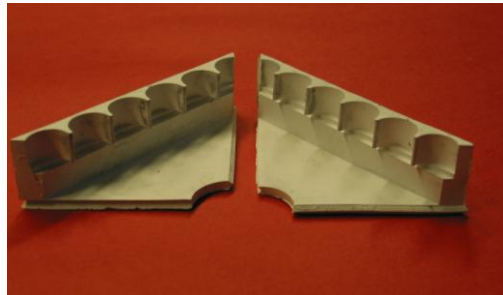
30 inch Cathode Tube



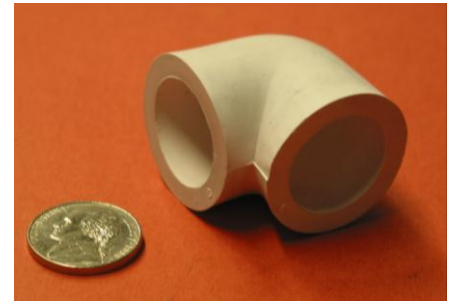
Alumina Cap



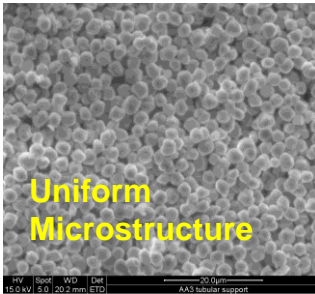
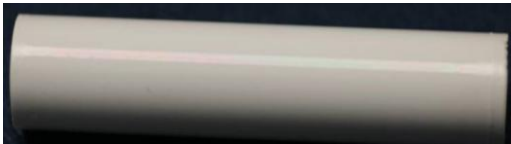
Carbide Nozzles



Alumina Part



Alumina Elbow



Tubular Membrane Support
H2 Separation



Composite Armor Breastplate

MetaMateria is interested in working with companies who have a parts application or an interest in using this fabrication technology. Applications in filtration, medical components, lighting, and energy systems are of particular interest.

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