# Application of gel-casting method in ceramics shaping


Vasiliki Chalkia[1], Elena Marathoniti[1], Nikolaos Vourdas[1], Pavlos Pandis[1], Antonios Gypakis[2], Vassilis Stathopoulos[1*]

[1] *School of Technological Applications, Technological Educational Institute of Sterea Ellada, Psachna, Evia, Greece*

[2] *General Secretariat of Research and Technology, Athens, Greece*



## Abstract

Gelcasting is a very promising forming process and was developed to overcome some of the limitations of other complex-shape techniques such as injection molding and slip casting. Moreover gel-casting technology has rapidly turned into a high research target in ceramic forming field due to the high strength, high density, low cost and machinable property of the formed green bodies since it was developed by Janney and Omatete in 1991[1].Gelcasting is an efficient method to manufacture complex-shaped component such as turbine rotors which need highly uniform properties. Also, gelcasting can be used in manufacturing of large components with simple shapes. In addition, gelcasting can be used in metal powder forming such as tool steel, a nickel-based superalloy etc [2].

The basic principle of gelcasting process is that ceramic powders are combined with a solvent, usually water, a dispersant, and organic monomers to form a high-solids-content, fluid slurry. The slurry is poured under conditions into a casting mold where by an initiator and catalyst the organic monomers polymerize to form a 3-D polymer network of a solid gel in the shape of the mold. The gelcast part goes through a volatiles removal step by calcination. The part is then sintered using the conventional firing treatment for the particular ceramic material. The main advantage of gelcasting is the forming of complex ceramic shapes. Crucial factors in the overall success of the process are drying conditions, and the mold features. A typical gelcast process flow chart is given in Figure 1.

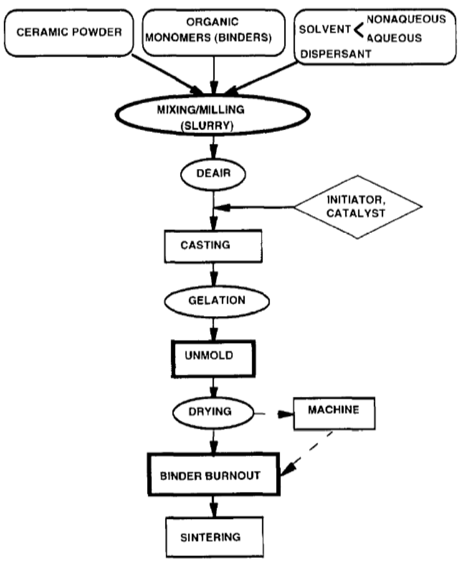


**Figure 1**.: Gelcasting process.

In this study we applied the gel casting method for the forming of complex ceramic shapes by various ceramic powders such as perovskite, silicate oxyapatite, α-alumina and yttria stabilized zirconia. The gel casting formulation consisted of an aqueous solution of water soluble monomer acrylamide (AM) and methylene–bis-acrylamide (MBAM) as cross-linker [3]. As initiator and catalyst, ammonium persulfate (APS) and tetra methyl ethylene diamine (TEMED) were used respectively. The inorganic powder solid content ranged from 50-80 wt%. The viscosity of the slurry was also studied versus the solid content to optimize rheological behavior of the gel casting formulation.

After gelation the green bodies were fired at 600$^{o}$C until all volatiles were removed. A final sintering step (1300$^{o}$C-1500$^{o}$C) was used to introduce the required mechanical and physicochemical properties to the ceramic structure. Prior any heating treatment the green bodies may subject to machining i.e cutting or drilling. Porosity and mechanical properties of the ceramic structures were studied. It was also observed that the final density, the shrinkage degree and the surface finish (cracking, warping etc) of the ceramics related to the initial ceramic powder solid content of the gel casting system.

**References**

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