Gelcasting of nanoceramic powders with a new water soluble monomers of low-toxicity

Prof. Mikolaj Szafran
The idea of gelcasting process

Gelcasting – a ceramic forming method, which connects traditional forming method with polymer chemistry. By means of an *in situ* polymerisation, a macromolecular network is created to hold the ceramic particles together.
Examples of application

In gelcasting method it is possible to receive ceramic parts of **complicated shape**!

- turbine rotors
- mini crucibles
- radomes
- heat exchangers
- medicine
The most popular monomer, used in gelcasting is **acrylamide**.

- Toxic, probably cancerogenic substance
- Contains nitrogen atoms in a molecule (during binder burnout there are harmful nitrogen compounds in released gases)
New organic monomers synthesized at Faculty of Chemistry Warsaw University of Technology

The gelcasting process was carried out without the use of crosslinking agent.

The green bodies obtained by *in situ* polymerization initiated with ammonium persulphate (initiator) in the presence of N,N,N′,N′-tetramethylethylenediamine (TEMED) (activator).
Glycerol monoacrylate - no need of external crosslinking agent

Received monomer can be applied without adding an external cross-linking agent, due to the presence of two hydroxyl groups in a molecule and possibility of forming hydrogen bonds between OH groups in polymer.
New monomers with $OH^-$ groups synthesized at Faculty of Chemistry Warsaw University of Technology

more hydroxyl groups in a molecule of monomer lead to:

- higher mechanical strength
- lower amount of polymeric binder
- higher density in green and sintered state
- lower amount of gas evolution in burn out process
New organic monomers synthesized at Faculty of Chemistry Warsaw University of Technology

The aim of following research is the synthesis of new monomers on the basis of saccharides, due to the presence of many hydroxyl groups in a molecule and their non-toxicity.

![Diagram of saccharide structure]
organic monomer

solvent + dispersant

examining rheological properties of a slurry

initiator + catalyst

deair

casting

polymerisation

unmould

drying

binder burnout & sintering

examining the properties of green bodies

examining the properties of sintered samples

the synthesis of new low-toxic monomers

Al₂O₃, Si₃N₄, ZrO₂, etc

ceramic powder

mixing (milling) a slurry
Thank You for Your attention!