Main plasticizing agents for the extrusion of ceramics:
- Methylcellulose (MC)
- Hydroxypropylmethyl cellulose (HPMC)
- Hydroxyethylmethyl cellulose (HEMC)

Main properties of Methylcellulose (MC):
- Viscosity
- Degree of Substitution (DS)
- Reversible Thermal Gelation
- Water retention
- Film formation
- Stickiness, lubrication, plasticization
- Rheology

 Hooks law is valid. Typical stress-strain curve of a deforming solid allows evaluation of:
- Wet green (bending) modulus (Youngs modulus)
- Wet green (bending) strength
- Wet green elongation at break

Extruded pastes behave mainly plastic, however, in a certain range of deformation they behave linear-elastic. Higher shape retention of the profile

A New Class of Methylcelluloses for Ceramic Extrusion at Elevated Temperatures which provides higher Shape Retention

3 Degree of Substitution (DS) of MC

Average "Degree of Substitution" (DS):
- Indicates how many hydroxyl groups of an anhydroglucose unit are etherified on average
- DS-values: theoretically 0-3 , in reality 1.3-2.2

Example:
- DS (Me) of commercially available MC: 1.64- 1.92
- DS (Me) of this newly developed MC: 1.4-1.5

4 Problem Description I

Extrusion of a ceramic paste above the gelation temperature leads to defect formation

Extrusion Temperature (°C)

Defect formation

Gelation temperature

Sample 5, DS (Me): 1.49
Sample 4, DS (Me): 1.54
Sample 3, DS (Me): 1.61
Sample 2, DS (Me): 1.78
Sample 1, DS (Me): 1.84

MC forms strong gels at high temperature

HPMC forms a weak gel structure at high temperature

5 Problem Description II

Increasing MC-addition rates lead to lower gelation temperatures: e.g. at 5 pph: gelation at room temperature
- Better cooling required
- Limited cooling capacity requires speed reduction
- More intensive cooling requires more energy (on industrial scale often electrical water cooling)

6 Solution: MC’s with a reduced DS (Me)

- The gelation temperature increases with decreasing DS (Me)
- A DS (Me) of 1.54 and lower leads to larger „temperature windows“ for extrusion

7 Evaluation of the Wet Green Performance

8 Results of Wet Green Testing

9 Final Conclusions

Current MC-trade products used as plasticizer in the extrusion of ceramics do have limitations:

A low gelation temperature that can lead to defect formation during extrusion

To overcome this difficulties the DS (Me) of the MC was reduced leading to:
- A gelation temperature up to 40°C higher
- The option to extrude at significant higher temperatures
- The option to extrude at significant higher speeds
- A ceramic paste having a higher wet green modulus
- Higher shape retention of the profile
- A minor elongation at break