Karlsruher Institut für Technologie

IAM
Institut für Angewandte Materialien

Process development for powder injection molding of short fiber reinforced ceramic-matrix-composites

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Contents

- Motivation
- Objective
- Process Flow
- Results
- Discussion

Motivation

Transformation from conventional into potential

Conventional oxide Ceramics (monolithic)

- Excellent high temperature and corrosion resistance
- High stiffness (mechanical stability)
- Low creep rate
- **low fracture toughness (brittle)**

+

Ceramic Fibers

(chopped Nextel 610 Alumina Fibers)

- High strength & stiffness
- **fibres proved capable of increasing the resistance to cracks and ductility, breakage strength**
- Sensitive to creep & grain growth

Ceramic Injection Molding

- Near-Net-Shaping
- Automation

Ceramic Matrix Composites (CMCs)

- All positive properties of conventional ceramics remain the same
- **Ceramic composite parts with increased fracture toughness**
- Precise parts can be produced fast & automated in large amounts

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Objective

Development of a process chain for the injection molding of short fiber reinforced ceramic oxide-oxide composites with *increased fracture toughness** and *acceptable strength*

*compared to non-reinforced material

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Process Flow

- **Powder characterization**
  - BET
  - Particle size and particle size distribution
  - Density
- **Feedstock production:**
  - Oxide-Powder (Al2O3: TM-DAR)
  - Oxide-chopped-Fiber (Nextel 610 fibers: ~3,2 mm in length)
  - Binder System: PE, Paraffin-Wax, Stearic acid
  - Viscosity and granulate preparation
- **[µ-] Injection Molding**
  - Disc-form
  - Tensile specimens
  - Other forms
- **Debinding**
  - chemically
  - thermally
- **Sintering**

Kneader (or Extruder)

High Pressure Capillary Rheometer

Kneader → Rheology → Injection molding → Debinding → Sintering

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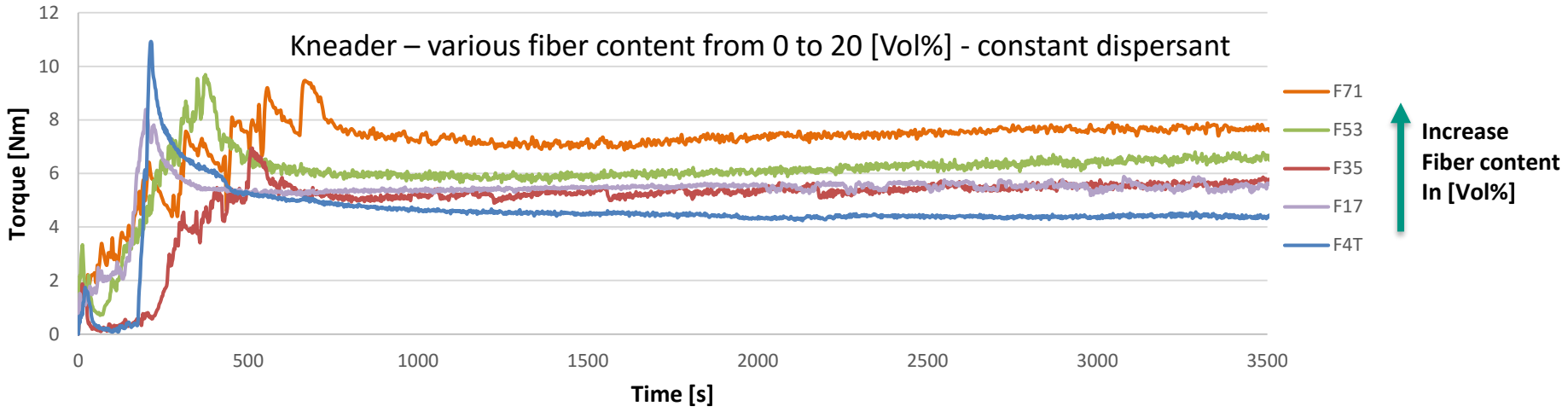
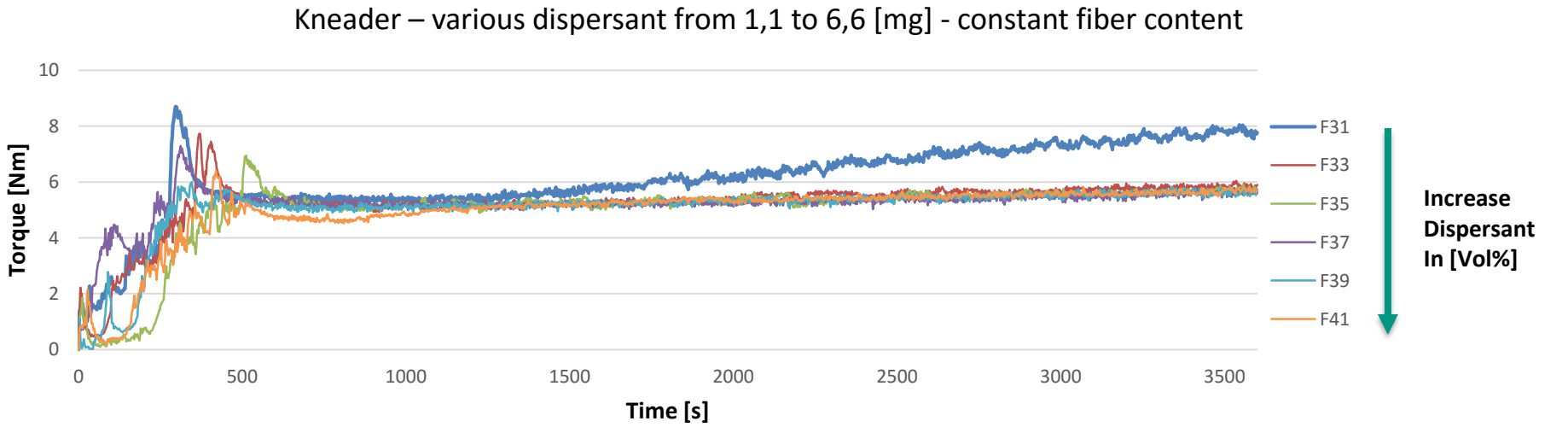
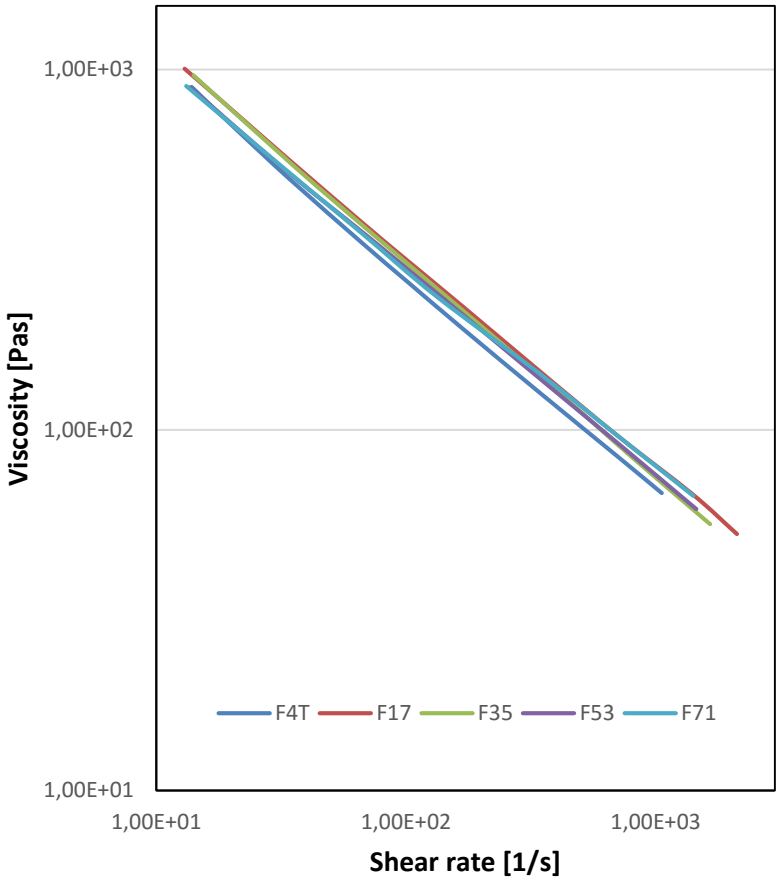
Results
Kneader



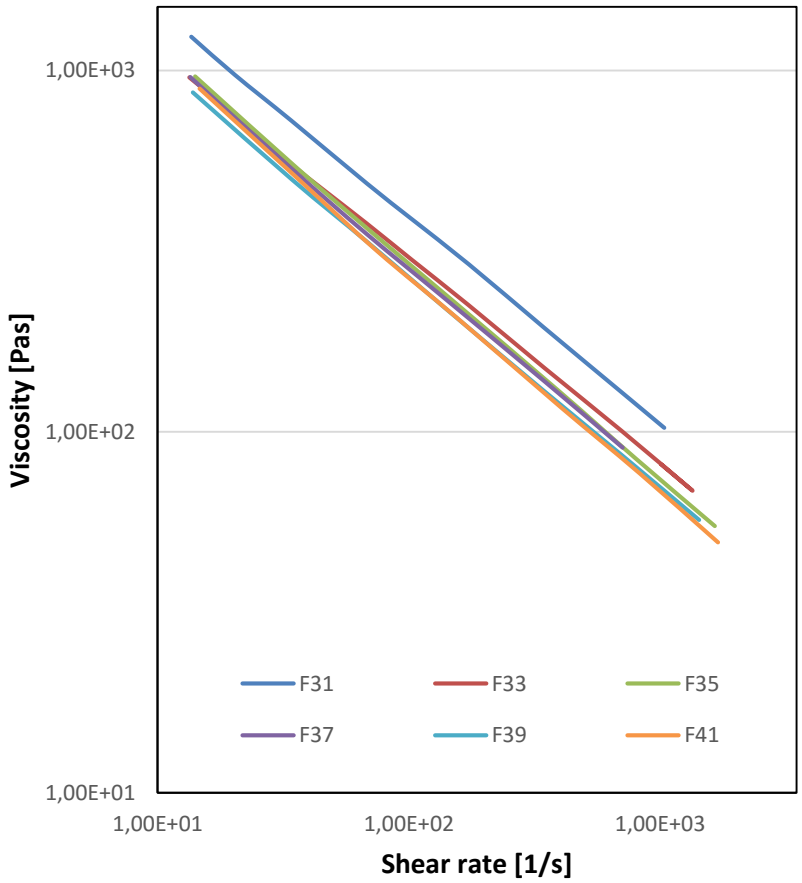


Results
Rheometer

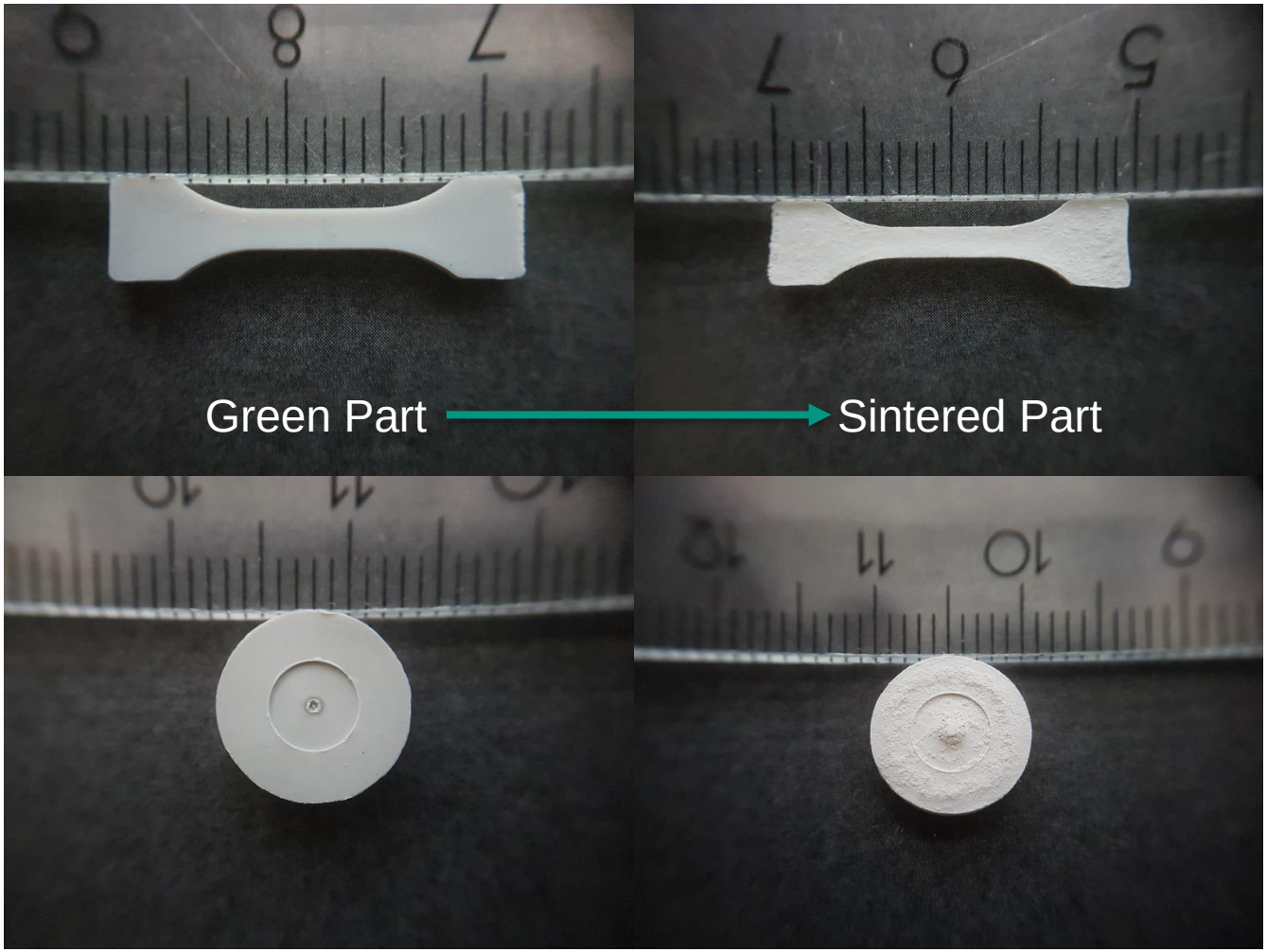
Rheometer – various fiber content – constant dispersant



Rheometer - various dispersant - constant fiber content



Results
Injection Molding



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Discussion

- By this process flow fibers are found in the sintered parts from 150 to 800 µm in length.

- The effectivity of debinding process step required further developments to improve time/cost performance and processability at higher fiber contents. To achieve that new binding systems will be researched.

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