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Glass-Injection-Molding; Investigation of the Complete Process Chain for a Commercial Glass Powder

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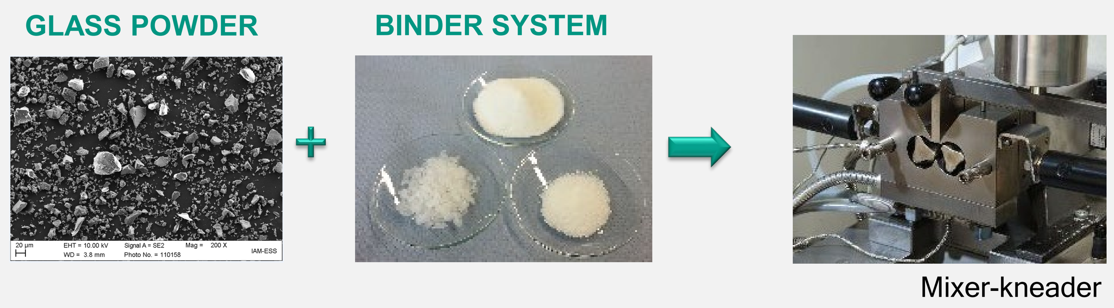
OBJECTIVES

Using Injection Molding as a technology for the fabrication of glass components is a highly attractive approach with the potential to cutting cost and energy. In addition, complex geometries can be manufactured. Powder Injection Molding is well known with metal and ceramic powder, for glass there is a lack of knowledge, particularly with regard to the replication and sintering behavior.

METHODS

FEEDSTOCK DEVELOPMENT



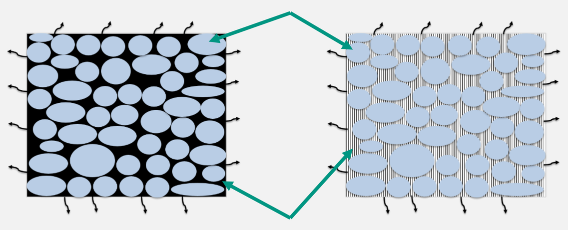
Mixing of the Schott glass powder „8250“ and the binder system consisting of polyethylene glycol, polymethyl methacrylate and stearic acid (PEG/PMMA/SA)

GLASS INJECTION MOLDING

The small samples are produced with the Battenfeld “Microsystem 50” injection-molding machine and the larger ones with an Arburg 420.

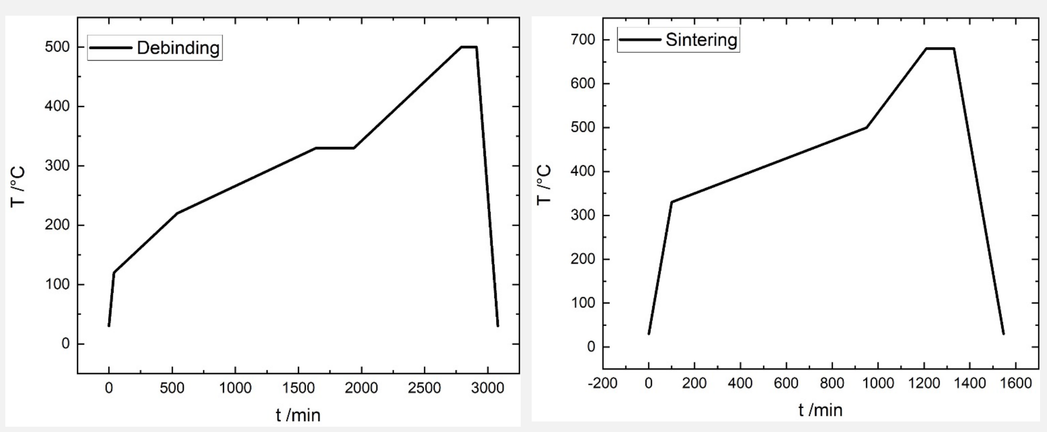
SOLUBLE PRE-DEBINDING

The water soluble part of the binder system (PEG) are removed in water to avoid cracks and other defects at the thermal debinding process step and also to reduce time at thermal debinding.



Schematic process of soluble pre-debinding: (left) in the green state, (right) after soluble pre-debinding

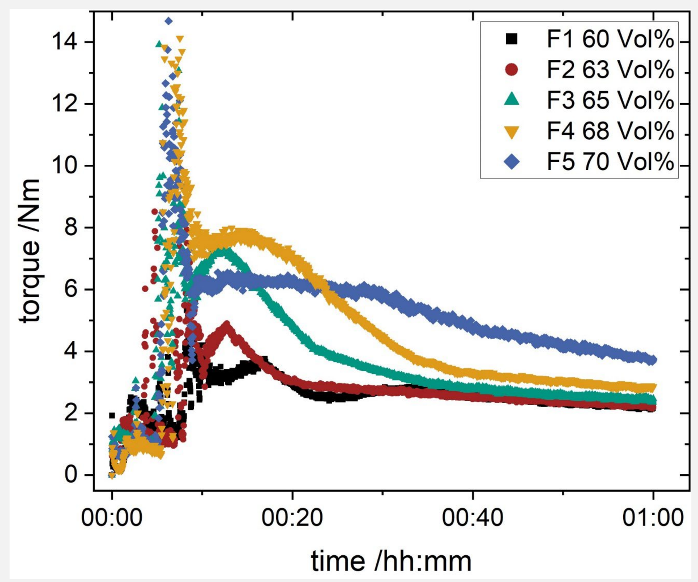
THERMAL DEBINDING / SINTERING

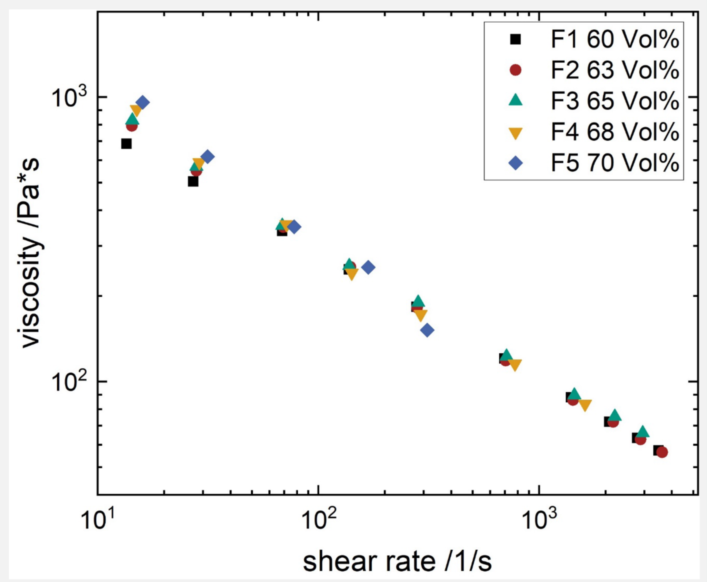


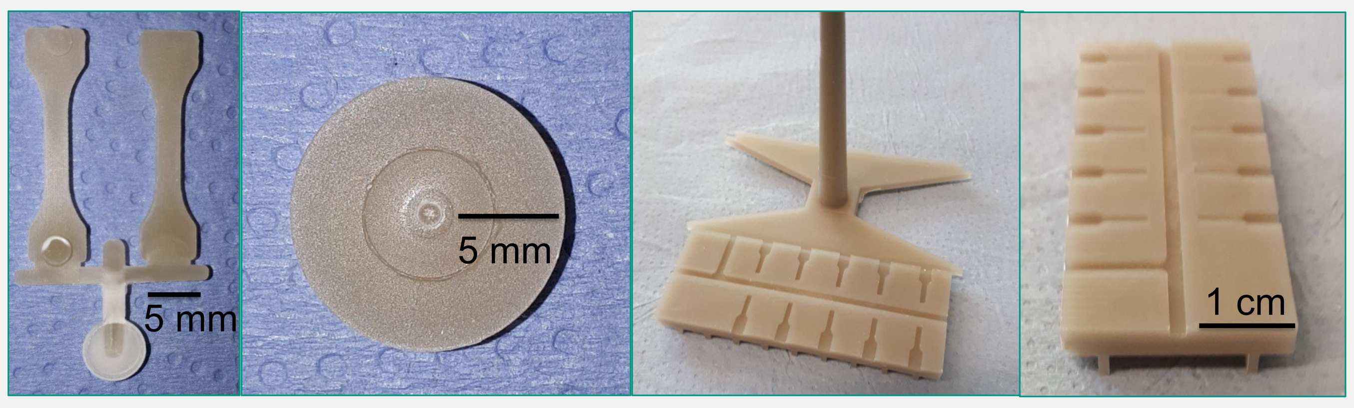
The soluble pre-debindered samples were then thermally debindered at 500 °C and subsequently sintered at 680 °C. Sintering was carried out under air conditions and under vacuum.

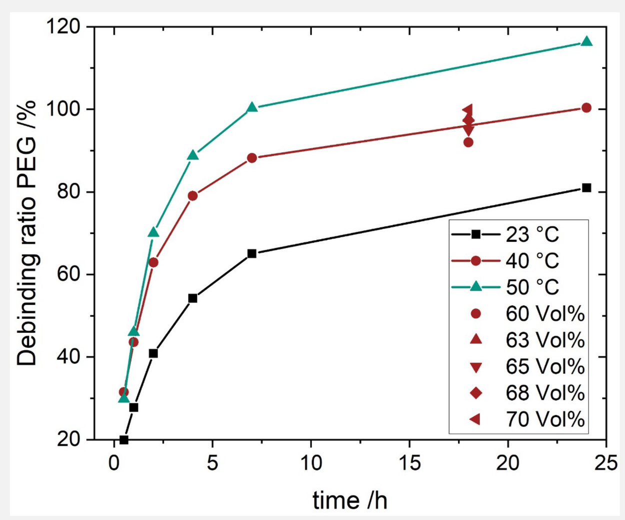
RESULTS

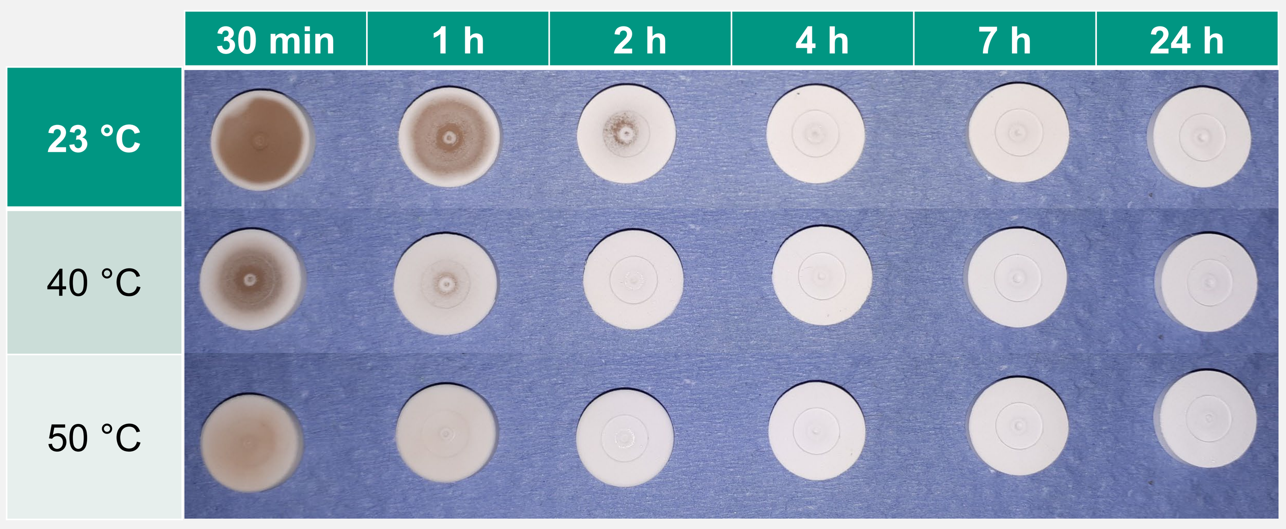
The main focus in feedstock development is on low feedstock viscosity combined with high green strength for a robust molding process. This is achieved with a feedstock of at least 60 Vol% glass powder, 20 Vol% PEG, 15 Vol% PMMA and 5 Vol% SA. In addition, the feedstock can be used for both small, precise components (< 1 cm) and large components (> 3 cm).



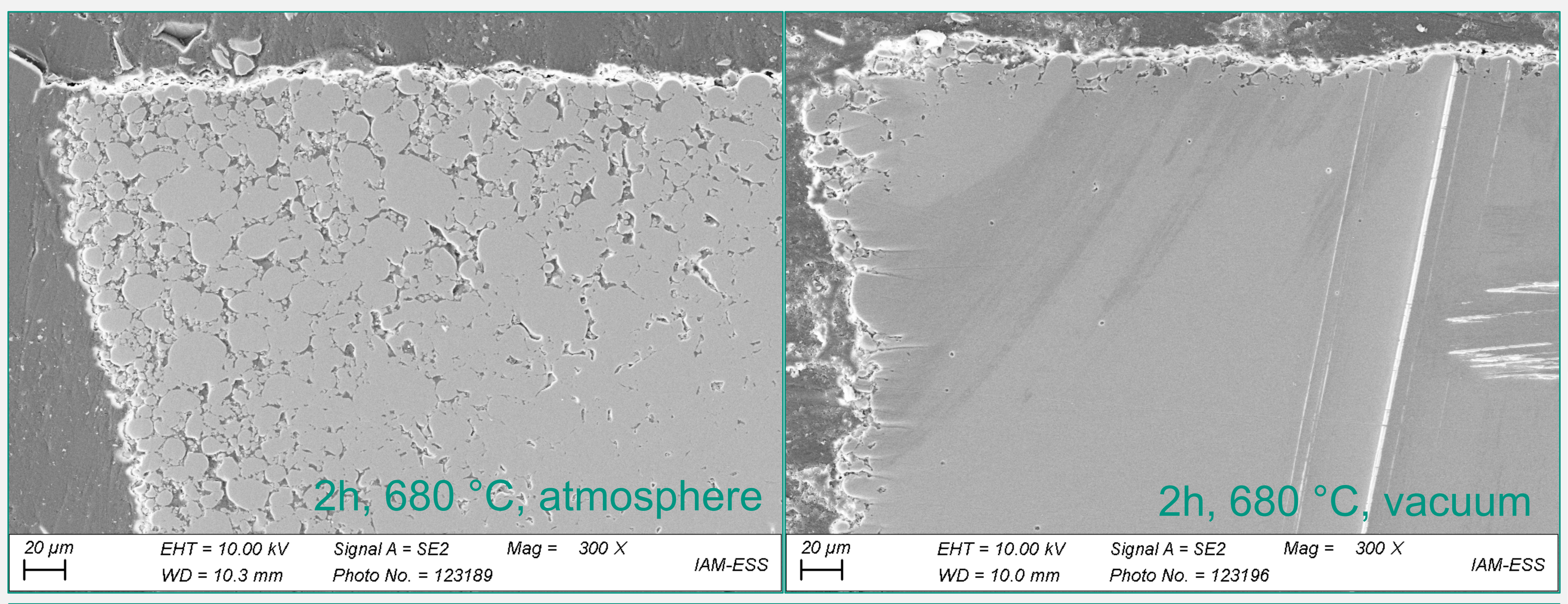




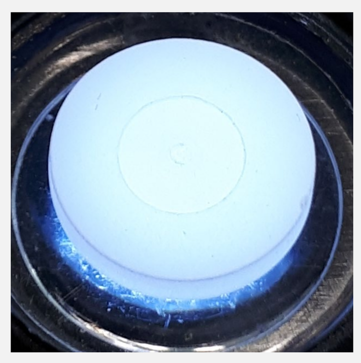




Dependence of the debinding rate of PEG on time and water temperature. After 16 h, a 90% debinding rate is achieved at a water temperature of 40°C, which is sufficient for the further process.



Compared to vacuum sintering, small bubbles can still be found in the component during sintering under air conditions, and the surface layer with an open porosity is somewhat thicker.



After sintering, glass samples are translucent because of the thin open porosity layer.

CONCLUSION

Injection molding was used to produce variously sized and challenging geometries for a commercial glass powder. For this purpose, the glass powder was embedded in a PEG/PMMA binder system. The components were then processed to the final product without distortion or defects by optimized debinding and sintering processes.

ACKNOWLEDGEMENTS

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