SAND2018-8699C

Material Properties of Ceramic Slurries for Applications in AM using Stereolithography

PRESENTED BY

Erin Maines

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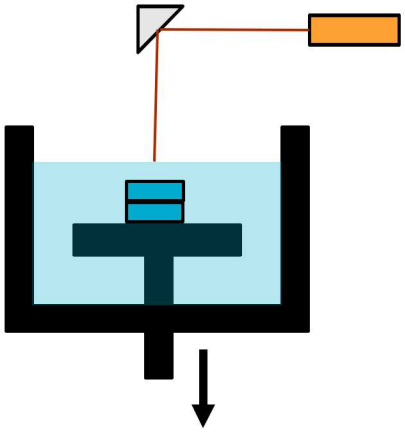
Stereolithography Overview

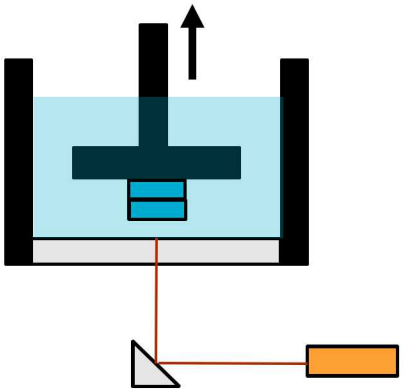
Stereolithography (SLA):

- An Additive Manufacturing (AM) form of printing using a UV light source to print a photosensitive polymer in a layer-by-layer method

Top-down Projection



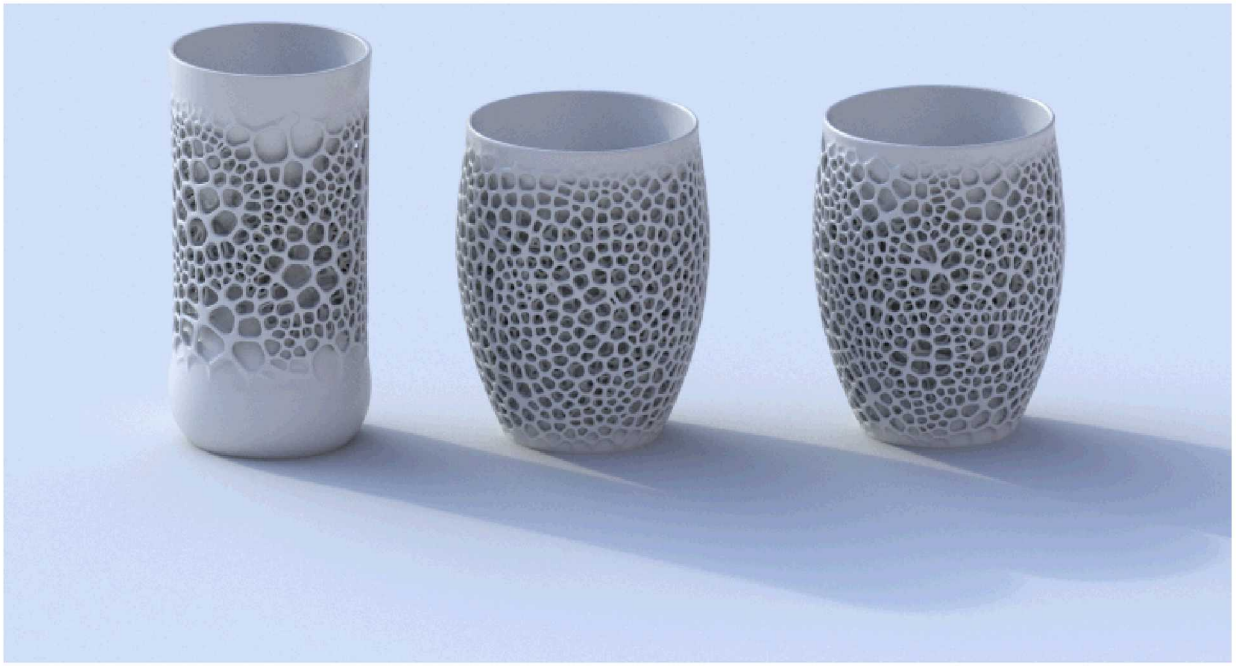
Bottom-up Projection



"High Resolution SLA and SLS 3D Printers for Professionals." Formlabs, 2018, formlabs.com/.

Background/Motivation

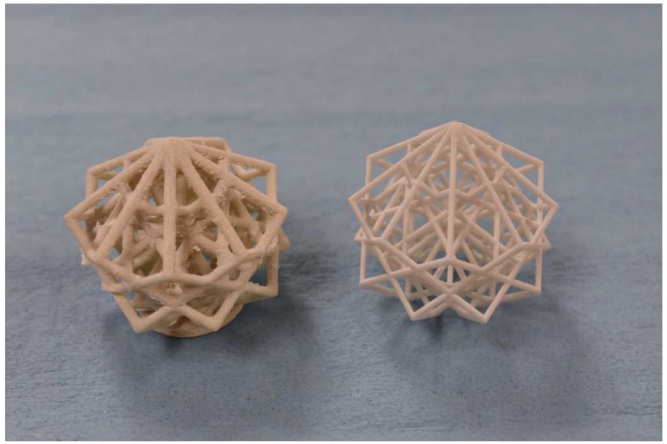
SLA allows for the creation of highly intricate ceramic parts that are difficult to make with conventional methods such as extrusion or press mold.



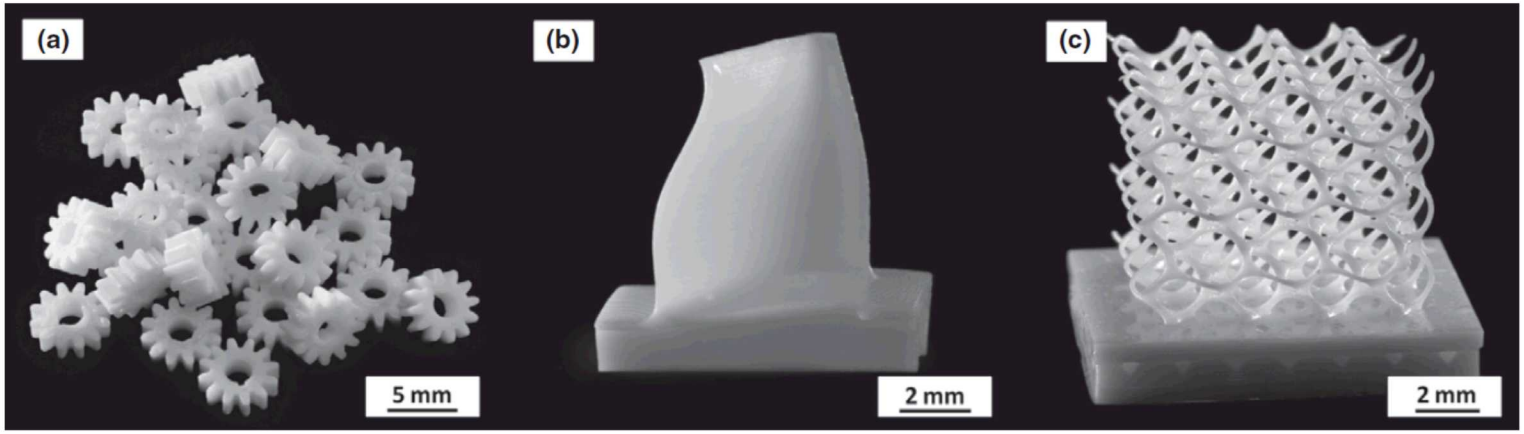
Jessica. (2016, 06 01). *Printing Porclain in 3D*. Retrieved from Nervous System Blog: https://n-e-r-v-o-u-s.com/blog/?p=7341

Background/Motivation

Commercially Available Ceramic Resin: Silica



Current Research: Alumina

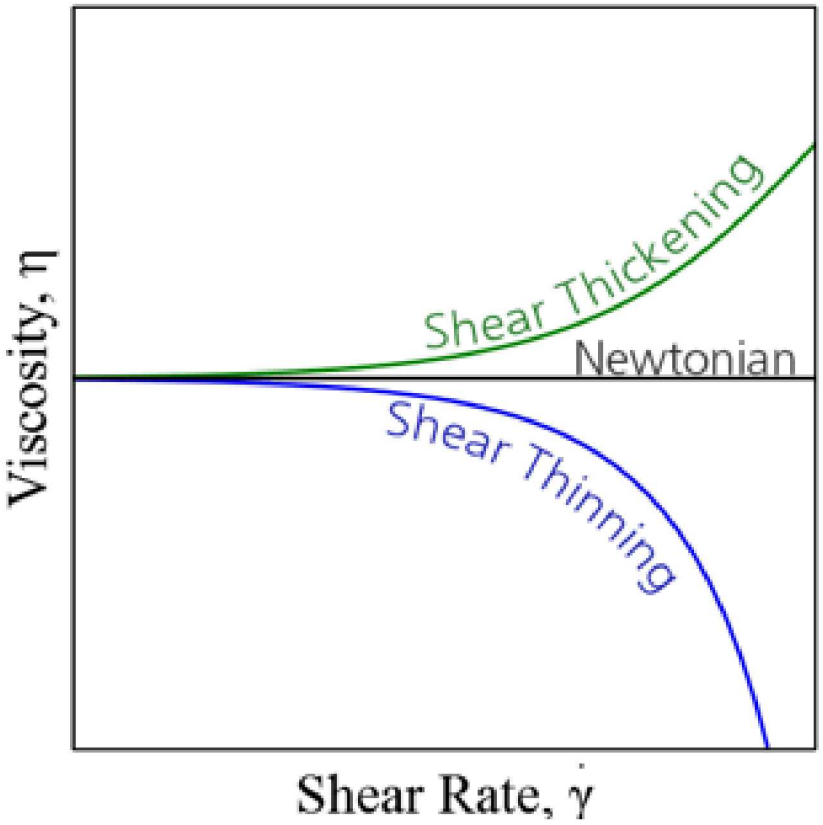


Tethon 3D. (2018). *Porcelite Ceramic Resin*. Retrieved from Tethon 3D: http://tethon3d.com/product/porcelain-ceramic-resin/

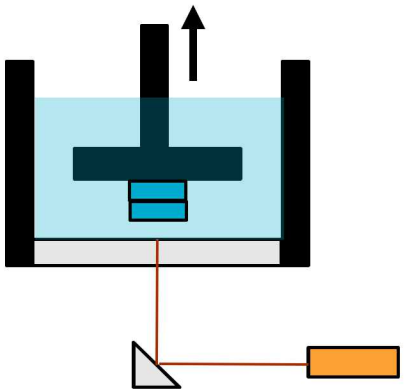
Schwentenwein, M., & Johannes, H. (2015). Additive Manufacturing of Dense Alumina Ceramics. *International Journal of Applied Ceramic Technology, 12*, 1-7. doi:10.1111/ijac.12319

Materials Characterization

Rheology allows for a measure of viscosity of the solution as a function of the shear rate.

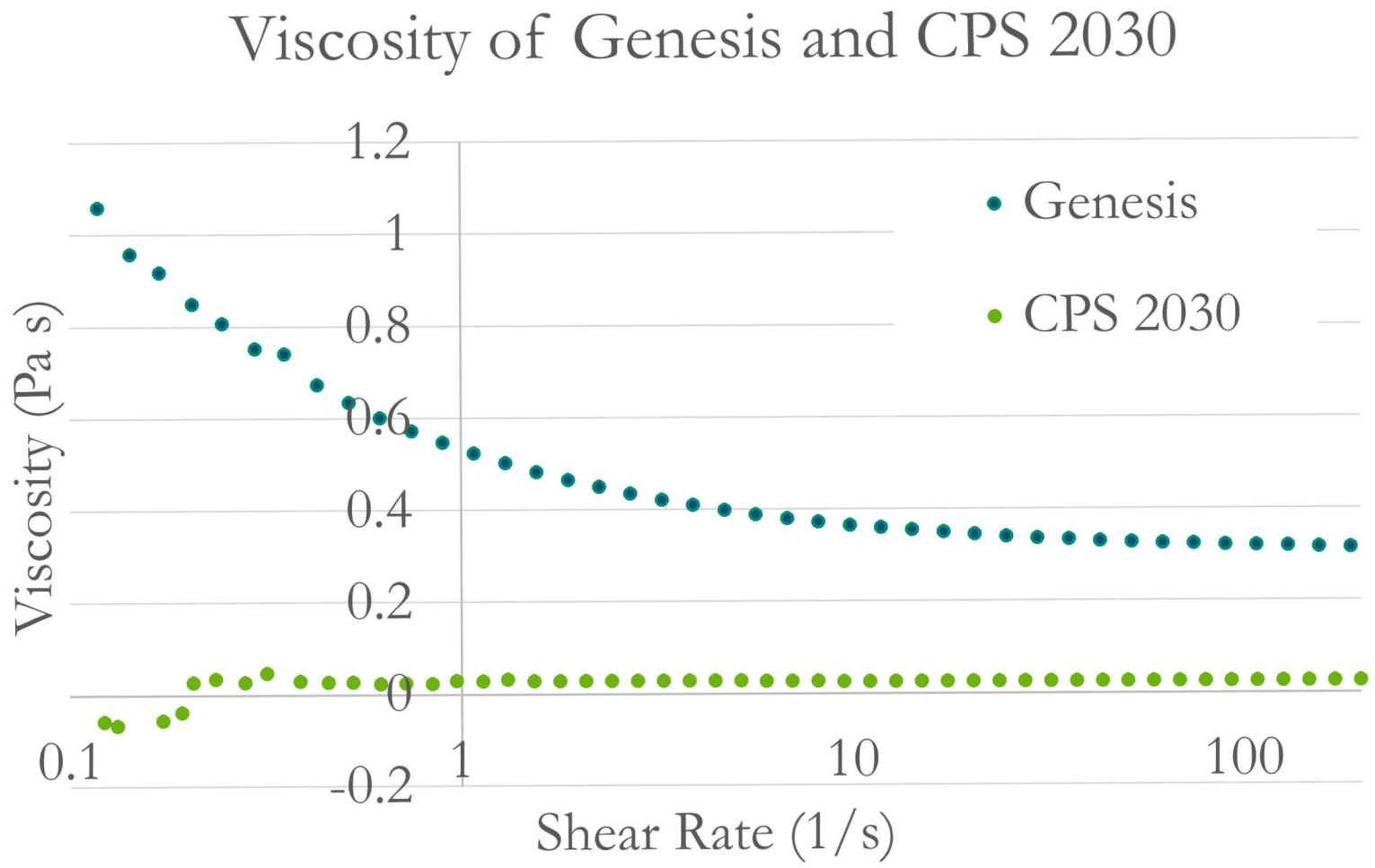


Bottom-up Projection



"Viscosity of Newtonian and Non-Newtonian Fluids." *Viscosity of Newtonian and Non-Newtonian Fluids*, RheoSense, 2016, www.rheosense.com/applications/viscosity/newtonian-non-newtonian.

Resin Choice



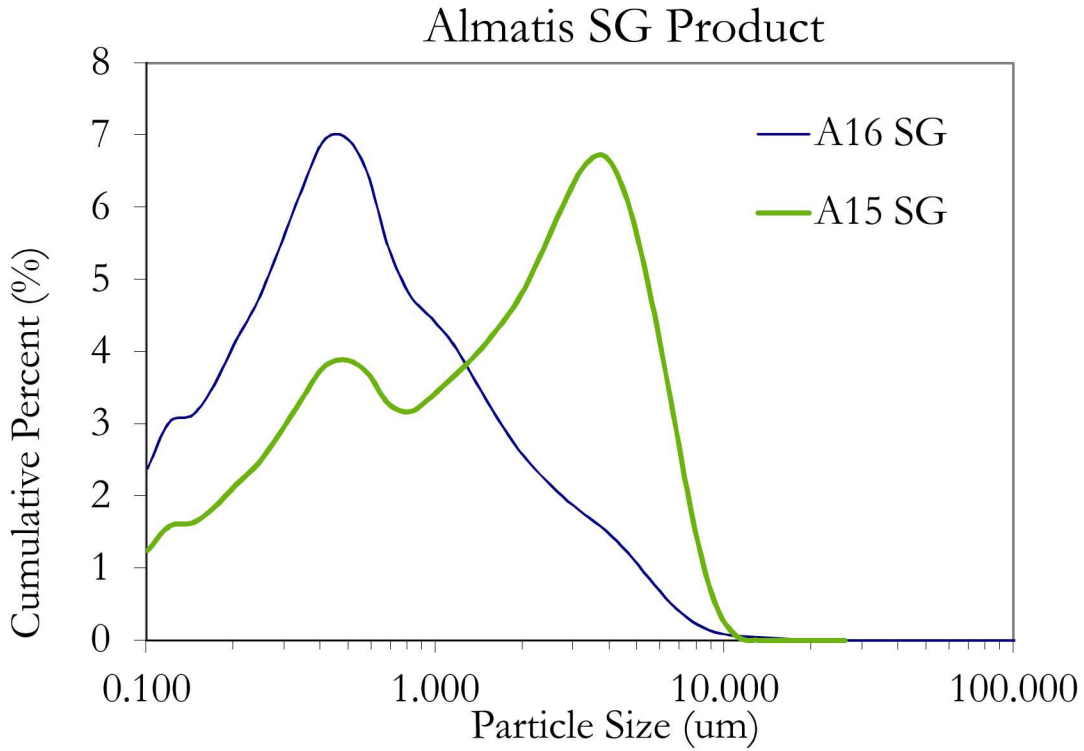
Materials

Dispersant: Hypermer KD1[1]

Low Viscosity Resin: CPS 2030

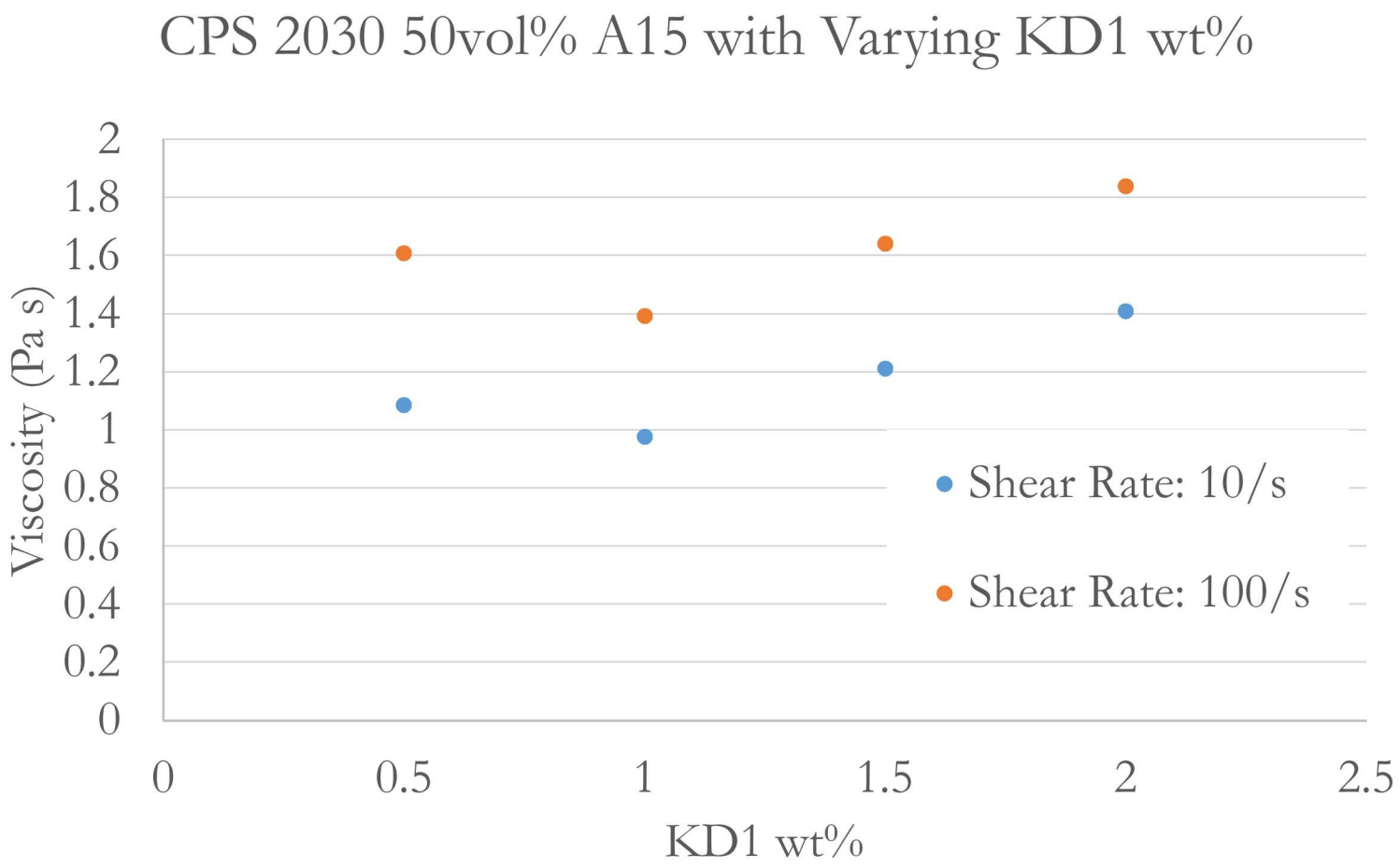
Viscosity: 0.026 Pa s

Alumina Powder: Almatis A15 SG and Almatis A16 SG

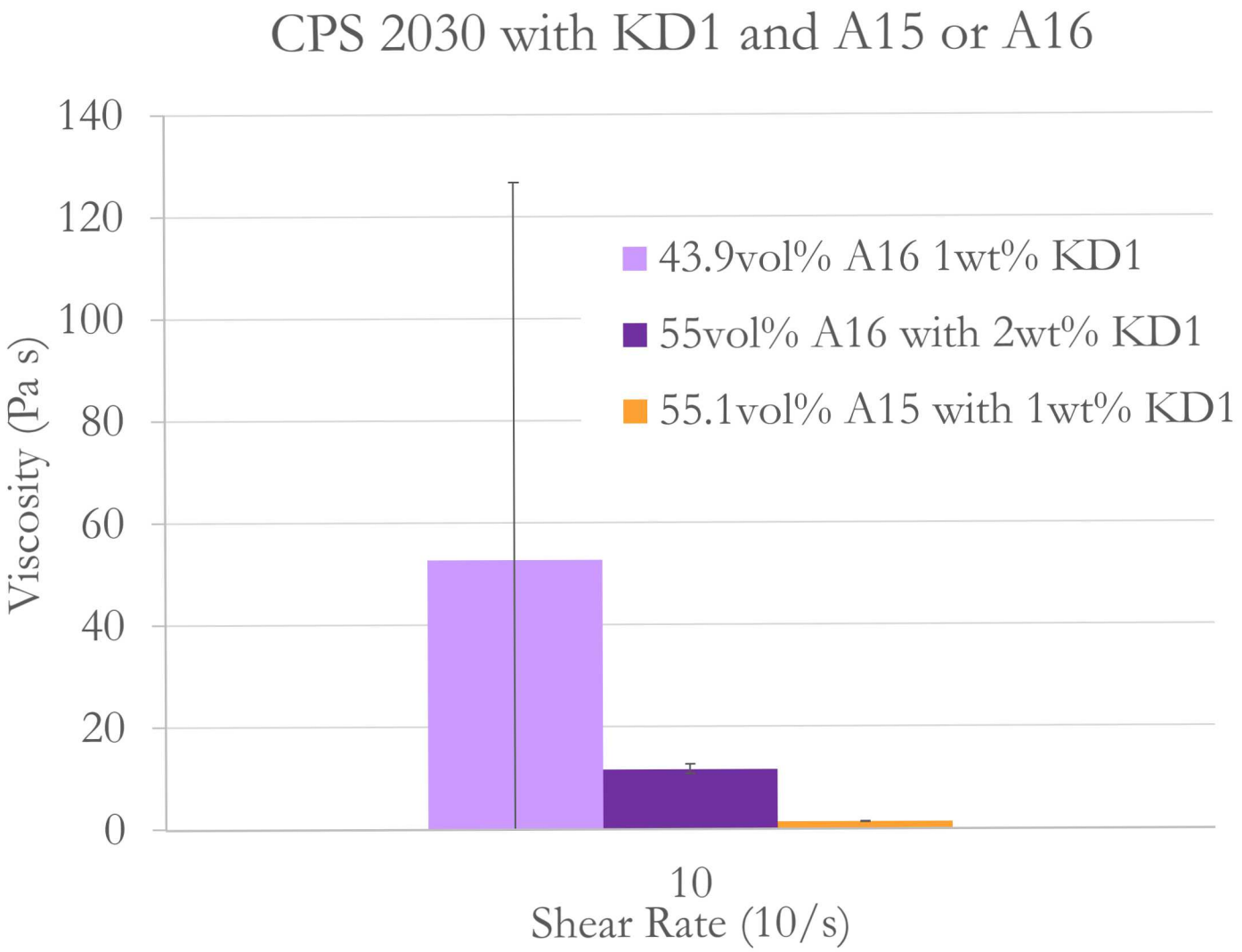


[1]Johansson, Emil; Lidstrom, Oscar; Johansson, Jan; Lyckfeldt, Ola; Adolfsson, Erik;. (2017). Influence of Resin Composition on the Defect Formation in Alumina Manufactured by Stereolithography. *Materials, 10*, 138. doi:10.3390/ma10020138

Dispersant Amount: A15



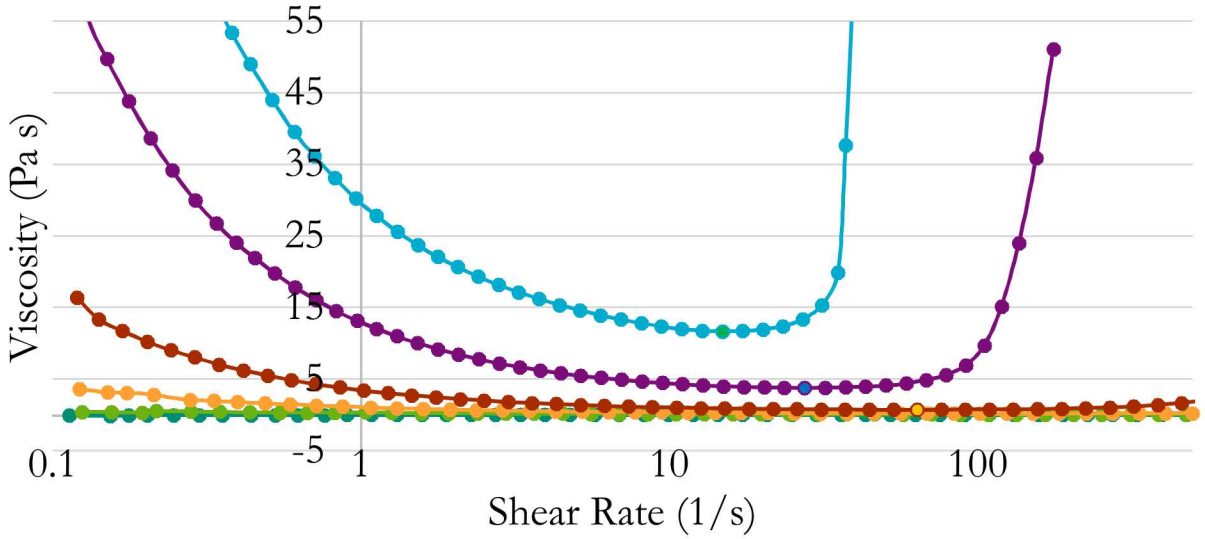
Dispersant Amount: A16



A15 vs A16 Powder Comparison

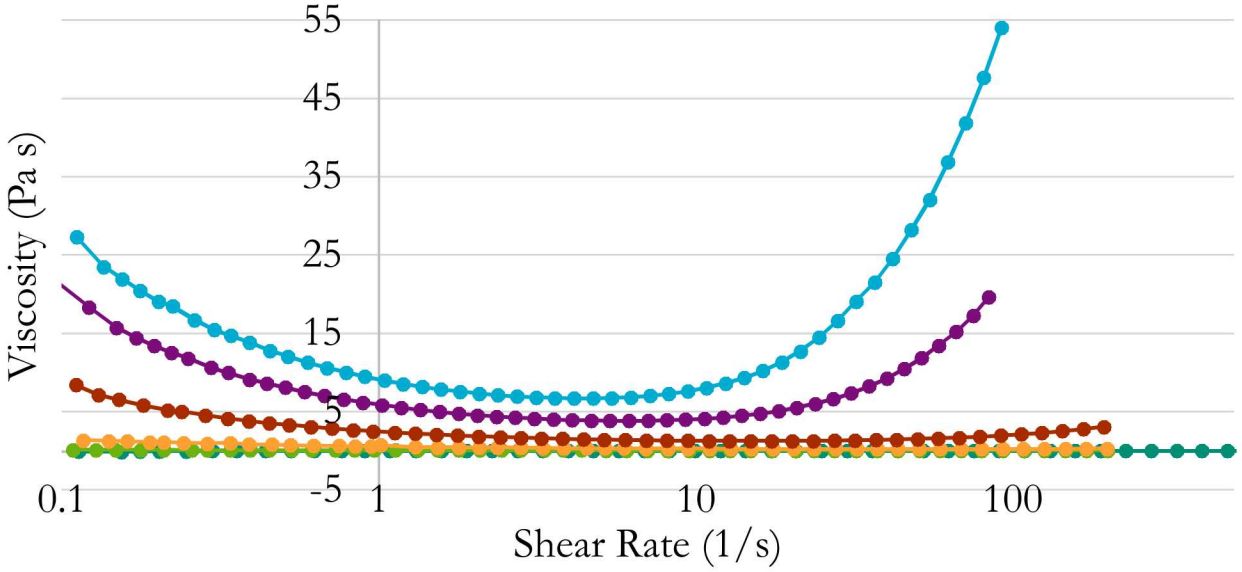
Varying A16 vol% with 2wt% KD1 in CPS 2030

- 0 vol% A16
- 25.29vol% A16
- 35.67vol% A16
- 45.27vol% A16
- 52.4vol% A16
- 55vol% A16



Varying A15 vol% with 1wt% KD1 in CPS 2030

- 0 vol% A15
- 20.06 vol% A15
- 40.47 vol% A15
- 55.1 vol% A15
- 63.19 vol% A15
- 65.1 vol% A15



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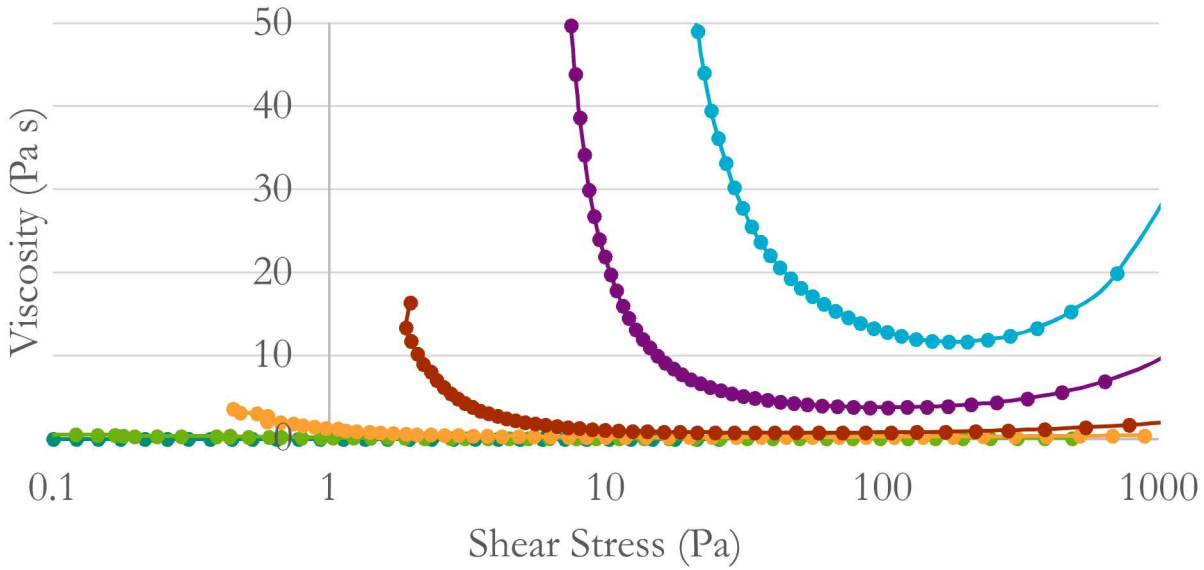

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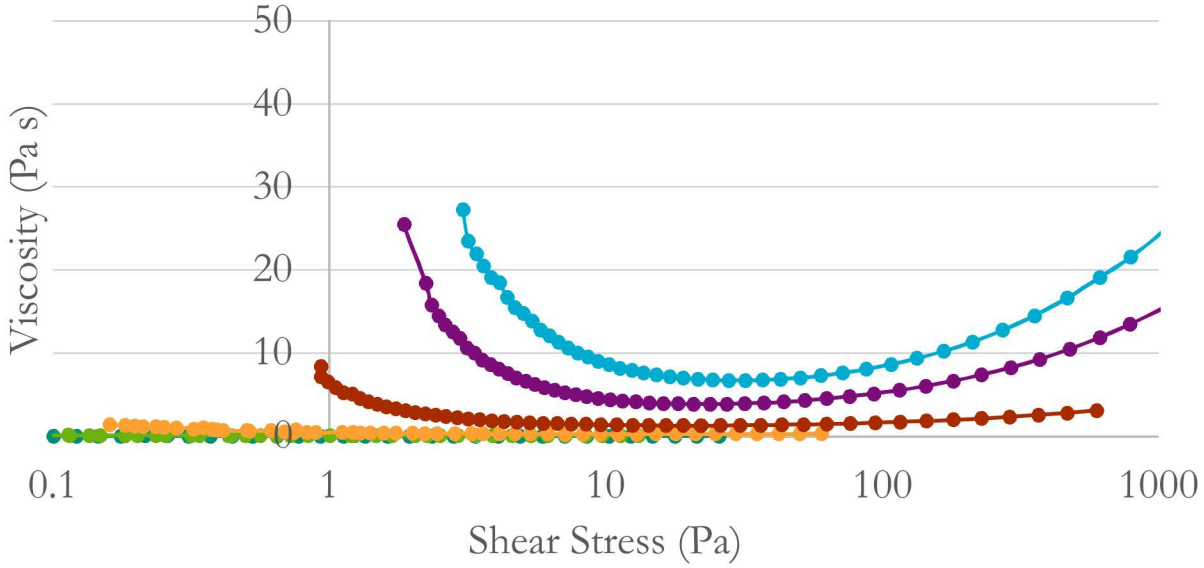
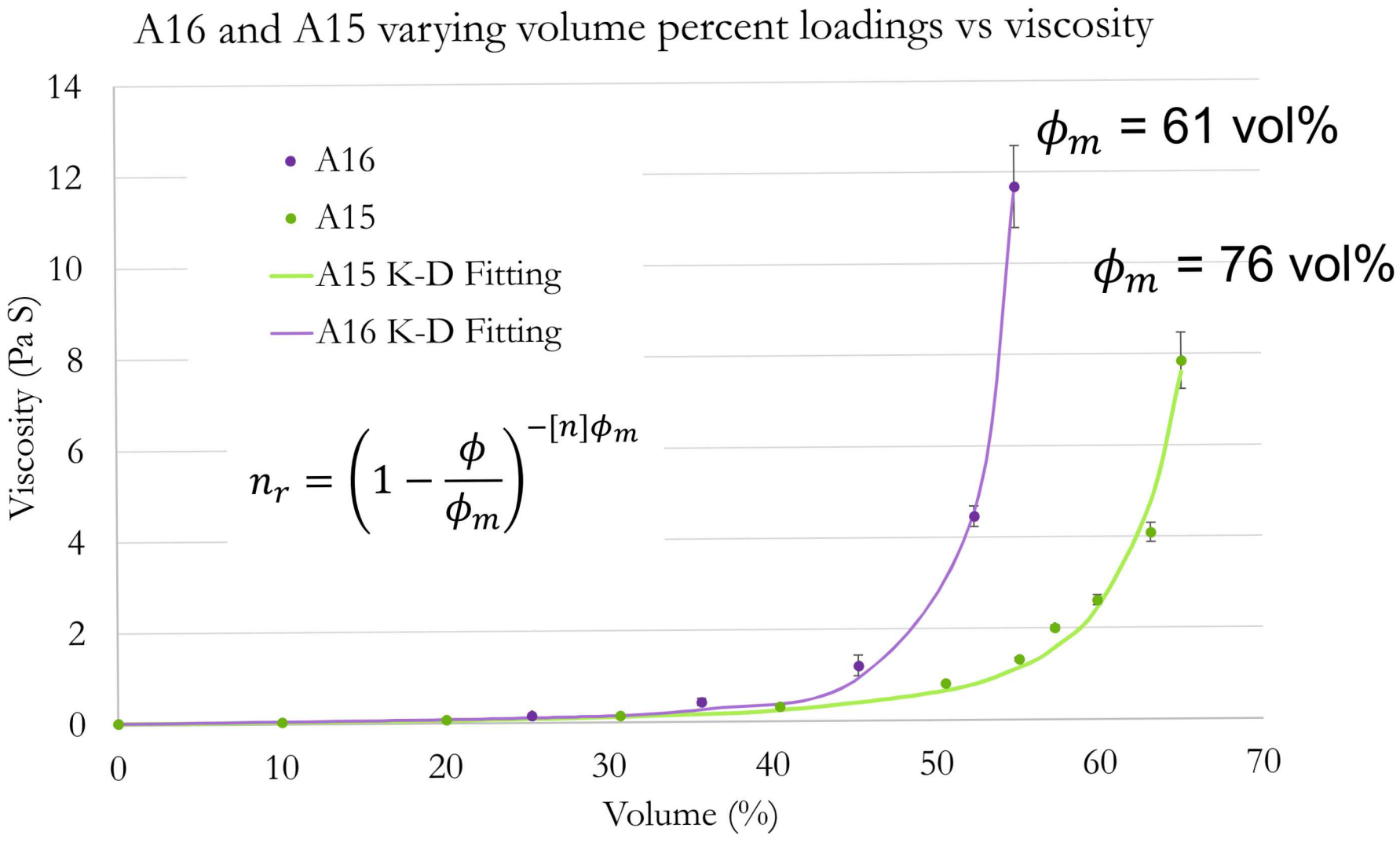
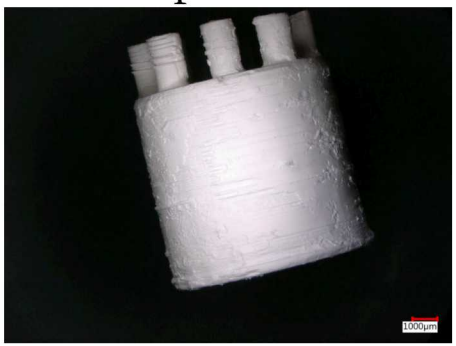


Krieger-Dougherty Equation



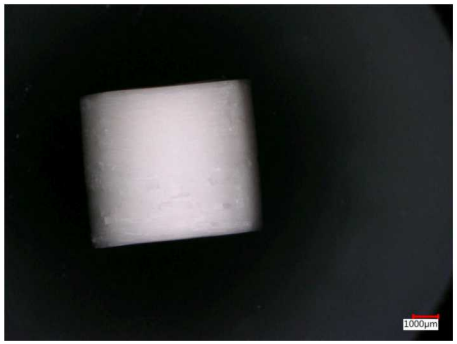
Final Parts

Unpolished



Polished

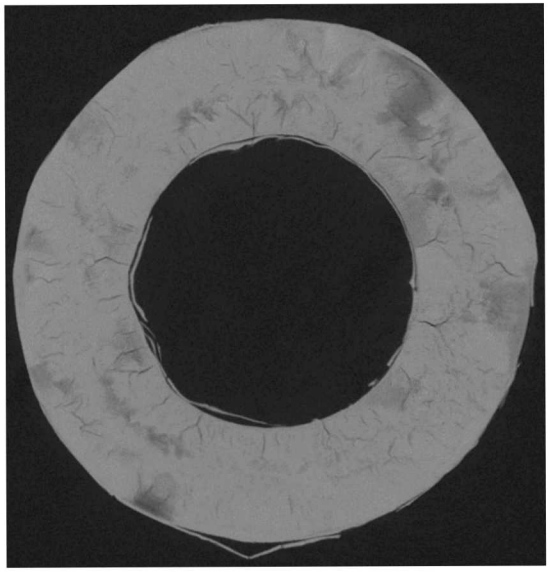
Sintered

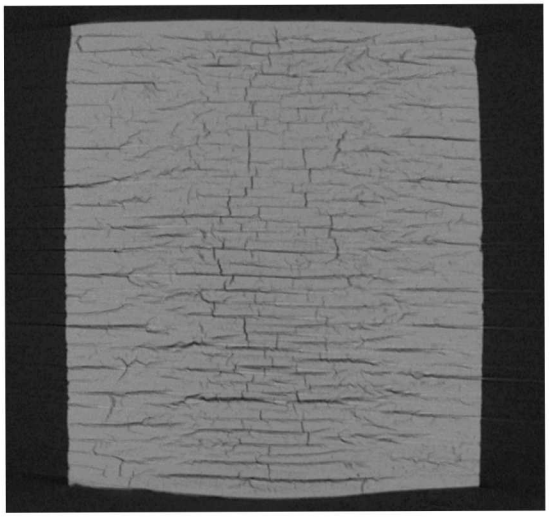


Part Identification	Volume Shrinkage
#1 Polished	40%
#2 Polished	32%
#3 Unpolished	29%
#4 Unpolished	35%
Average	**34% ± 5%**

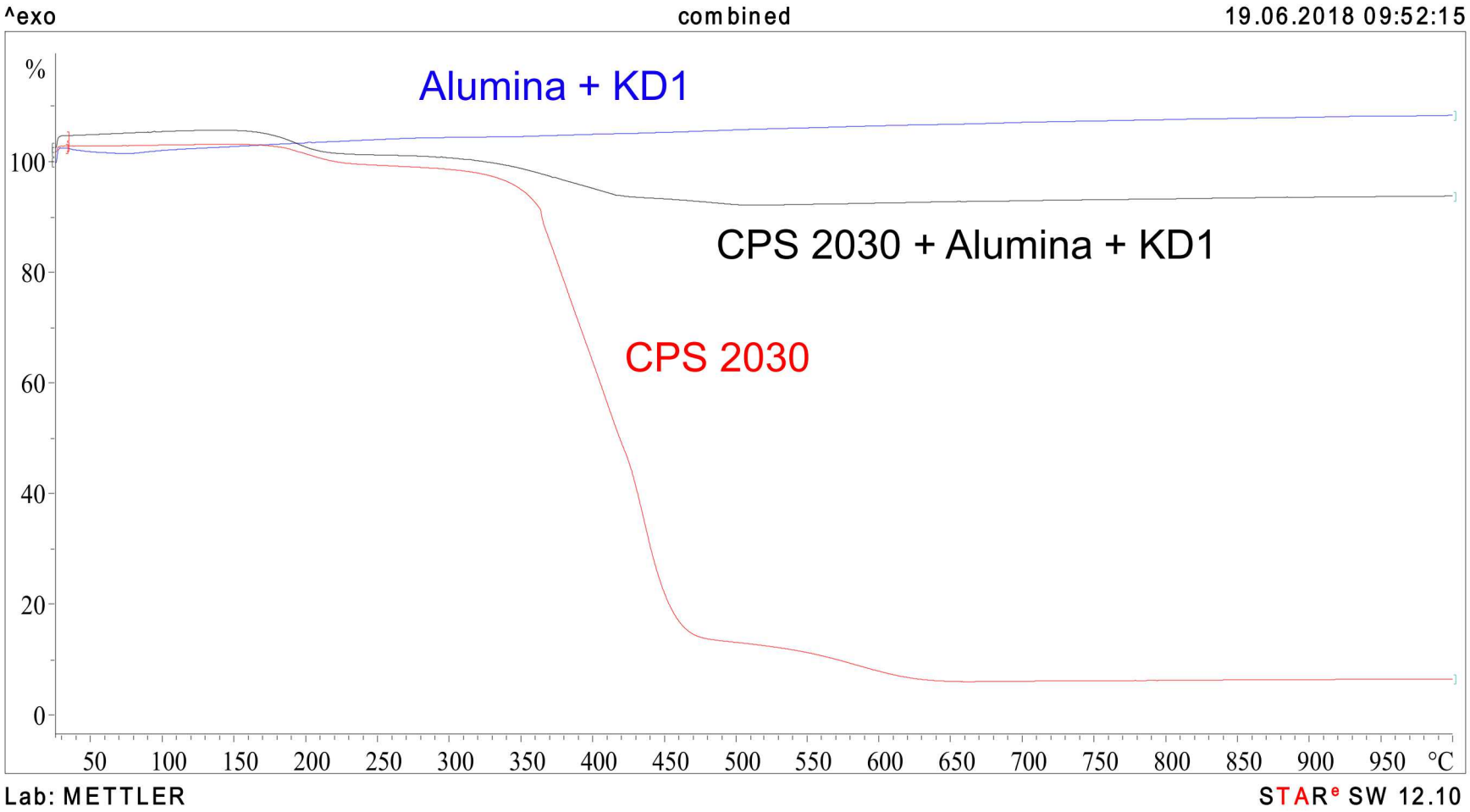
Final Parts

Part Identification	Density
#1 Polished	91.8%
#2 Polished	90.5%
#3 Unpolished	89.3%
#4 Unpolished	88.7%
Average	**90% ± 1.4%**





Future Work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Alumina + KD1
CPS 2030 + Alumina + KD1
CPS 2030
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Acknowledgements

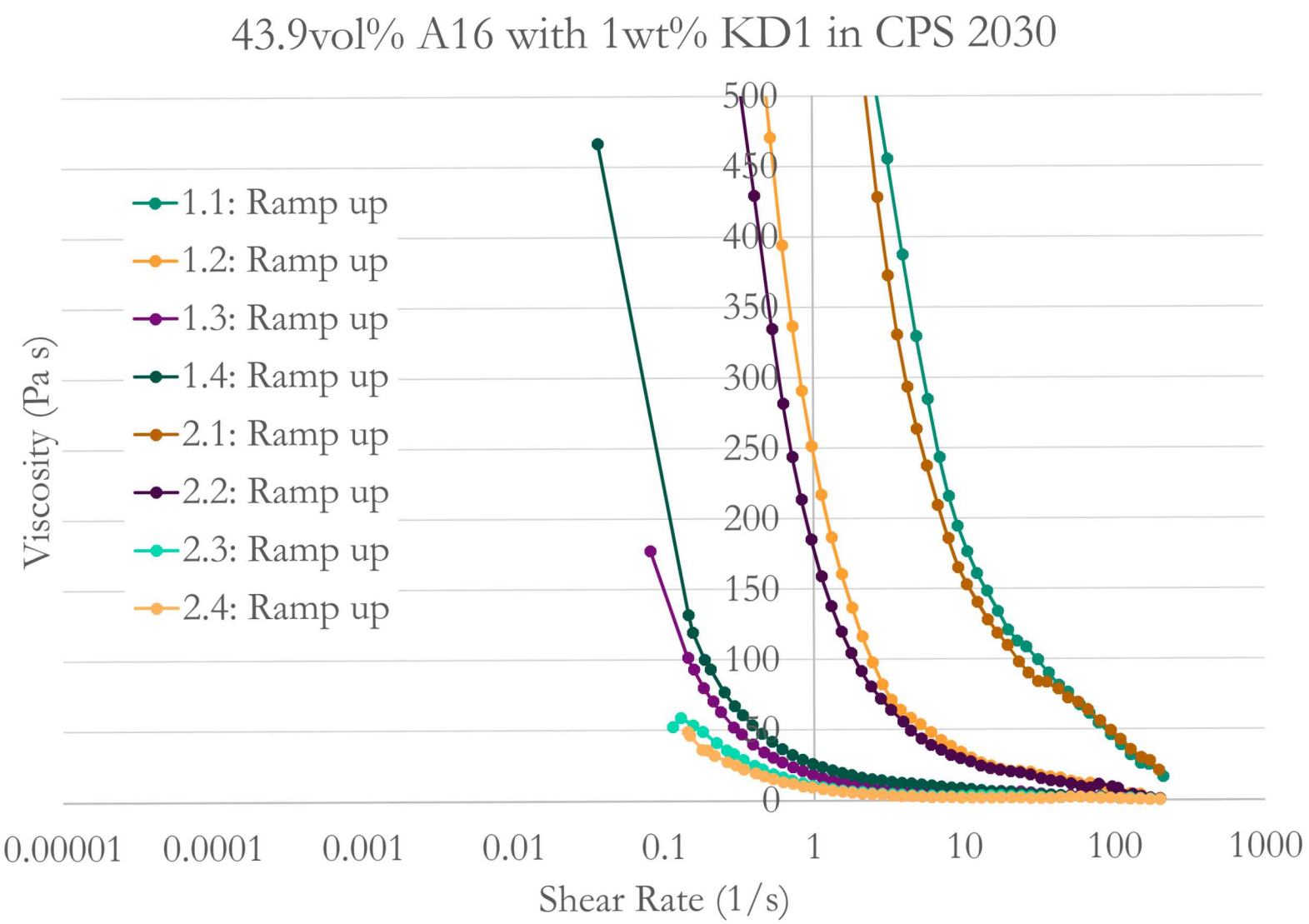
Special Thanks To:

Sandia National Labs
Born Qualified Program

Allen Roach
Judith Lavin
Nelson Bell
Matthew Roach
Lok-kun Tsui
Lindsey Evans
David Keicher
Joseph Romero
Tim Boyle
Pin Yang

Supporting Slides

Supporting Slides



Supporting Slides