Nanoindentation of Silica Colloid Thin Films Sintered at Various Temperatures

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Introduction

A Hysitron nanoindentor was used to test the hardness and reduced modulus of several two sample groups. These samples consisted of silica colloids deposited onto glass slides that were sintered at various temperatures. Students prepared silica colloid samples of comparable properties, one set was sent to the company Hysitron from UW-Stout in 2009, the other was sent to UW-Eau Claire from Carthage College in 2017. The aim for this project was to confirm data found by Hysitron. The ongoing project at Carthage needed confirmation that the way the samples were prepared were consistent with previous methods. Our findings indicated that the samples sintered at higher temperatures had a higher hardness and reduced modulus, which was also determined by Hysitron. The goal of this was to show that the process of creating the samples were reproducible and accurate.

Next Steps

Data on the thickness of the silica layer will be collected. We have received a new set of samples that were produced by a method of spin coating the silica onto glass slides. Research will continue over the summer.

Acknowledgments

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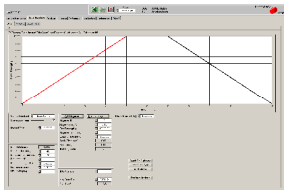
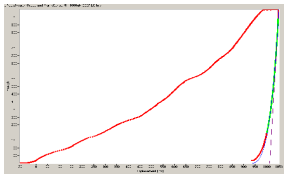
Methods

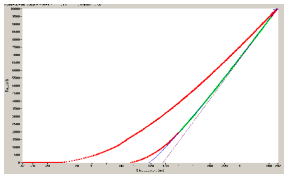
Using the Hystiron Nanoindentor, a load function of five second approach, two second hold, and five second unload was used for each of the samples.



The 1100 C, 1000 C, 900 C, and 800 C samples were tested at a maximum load of 10,000 µN. The 700 C maximum load was 2,500 µN. The Control maximum load was set at 1,000 µN.
On each sample we tested 15 points in a concentrated area. We then tested five to eight points on various spots on the sample, making sure to stay over the area of the magnet to ensure a stable surface for the diamond tip to approach.

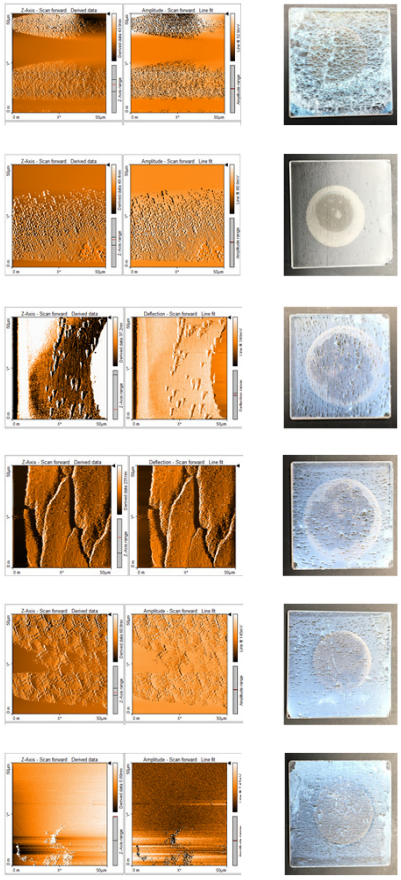


Control



1100 C

Results



Control

Average

Collected Data	From Hysitron Report:
Modulus: 4.168 GPa	Modulus: 5.592 GPa
Hardness: 0.035 GPa	Hardness: 0.156 GPa
Contact Depth: 1090.029 nm	Contact Depth: 244.069 nm

1100 C

Average

Collected Data	From Hysitron Report:
Modulus: 53.894 GPa	Modulus: 53.853 GPa
Hardness: 6.619 GPa	Hardness: 5.580 GPa
Contact Depth: 173.373 nm	Contact Depth: 244.238 nm

1000 C

Average

Collected Data	From Hysitron Report:
Modulus: 21.325 GPa	Modulus: 22.960 GPa
Hardness: 0.467 GPa	Hardness: 0.695 GPa
Contact Depth: 961.454 nm	Contact Depth: 305.343 nm

900 C

Average

Collected Data	From Hysitron Report:
Modulus: 19.039 GPa	Modulus: 14.783 GPa
Hardness: 0.147 GPa	Hardness: 0.286 GPa
Contact Depth: 1625.050 nm	Contact Depth: 609.311 nm

800 C

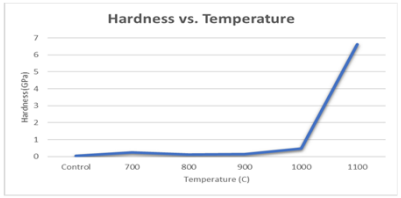
Average

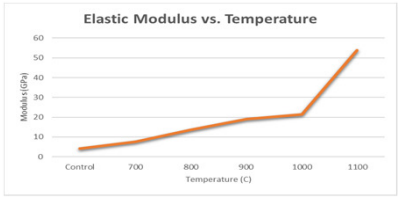
Collected Data	From Hysitron Report:
Modulus: 13.535 GPa	Modulus: 10.323 GPa
Hardness: 0.124 GPa	Hardness: 0.278 GPa
Contact Depth: 1784.800 nm	Contact Depth: 427.550 nm

700 C

Average

Collected Data	From Hysitron Report:
Modulus: 7.579 GPa	Modulus: 8.242 GPa
Hardness: 0.245 GPa	Hardness: 0.197 GPa
Contact Depth: 511.738 nm	Contact Depth: 514.967 nm





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