

# Center for Additive Manufacture of Advanced Ceramics (CAMAC)

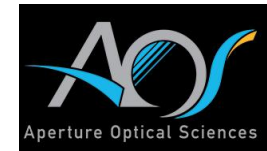
Nov 29<sup>th</sup>, 2022

<https://camac.charlotte.edu/>

*Materials*

*Process*

*Post-Process*



...



## ○ CAMAC Community building

- Networking
- Seed funding
- Travel grants <https://camac.charlotte.edu/funding-opportunities>
- Bi-Annual meetings



## ○ CAMAC Infrastructure

- Equipment updates to follow – Dr Schmid
- Proposals submitted – DoD’s Research and Education Program for MSI – not funded – NSF’s MRI is an option.
- ...

## ○ CAMAC Sustainability

- Go beyond ROI grant life span ...

## May 31<sup>st</sup> meeting

- Hybrid format: In-person and zoom (~40 Attendees)
- Presentation: SLA market and capabilities – 3DCeram
- Project updates given:
  - Discrete Element Method Analysis of Ceramic Powders for Advanced Manufacturing - S. *Shenouda*/T. Abu-Ledbeh (NC A&T)
  - 3D printing/Additive manufacturing of photocurable silicone carbide-polymer composite with densified microstructures - *T. Raham*/E. Baynojr Joyee & A. El-Ghannam (UNCC)
  - Spatial Analysis of Additively Manufactured Ceramic Surfaces - T. Barret-Crvich, A. Maron/ B. Mullany (UNCC)
- 3-minute flash talks rounds
- Tours

## July 26<sup>th</sup> Meeting

- Online format-to hear project proposal presentations.
- 5 project proposals received - external reviews from National Labs (thank you!)
- 3 selected for funding
  - 3D Printing of Ultra-High Temperature Ceramics (UHTCs) using Selective Laser-induced Reaction Sintering (SLRS) Process – *C. Xu and T. Fang (NC State)*
  - Direct Ink Writing of SiC/C Ceramic Matrix Composites – *Y. Chen and E. Joyee (UNCC)*
  - Correlating Component Integrity with Surface Characteristics at Each Stage of Ceramic AM Manufacturing – *A. Allen and B. Mullany (UNCC)*
- One proposal on application - brief update will be given
  - Ceramic AM for micro-scale flexural devices – *S. T. Smith (UNCC)*

## 3DCeram C100



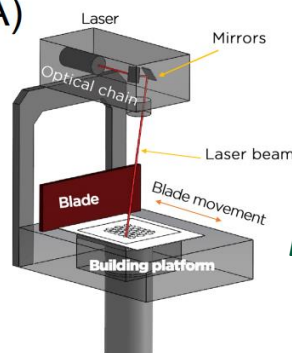
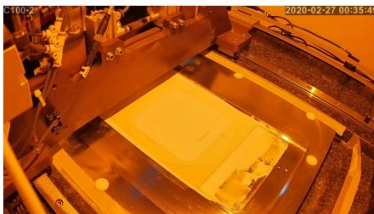
### Specs:

- Photopolymerization
- UV @405 nm
- Laser spot ~50  $\mu\text{m}$
- Build size 100×100×150 mm

### Training:

- 4- day onsite complete
- 2 Zoom session complete
- 2 Zoom sessions remaining

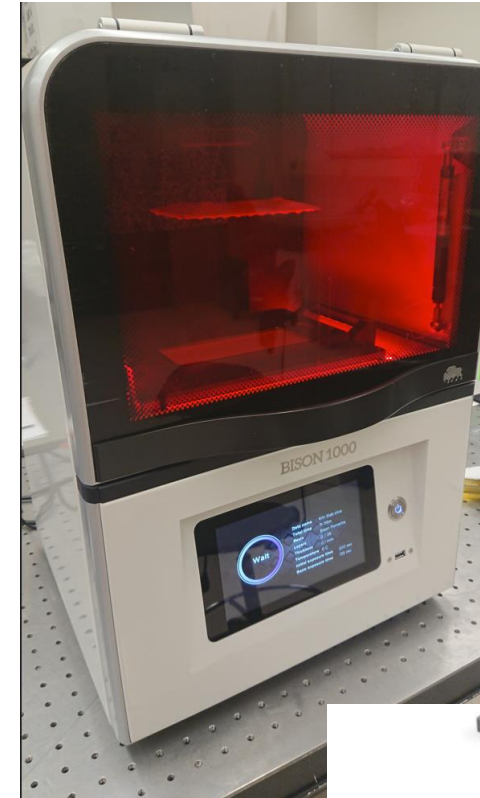
### Stereolithography (SLA)



*Build tray down*



## Bison 1000

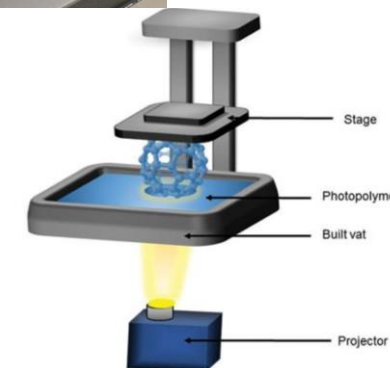


### Specs:

- Photopolymerization
- UV @405 nm
- Digital light projection
- Build size 10 × 60 × 138 mm

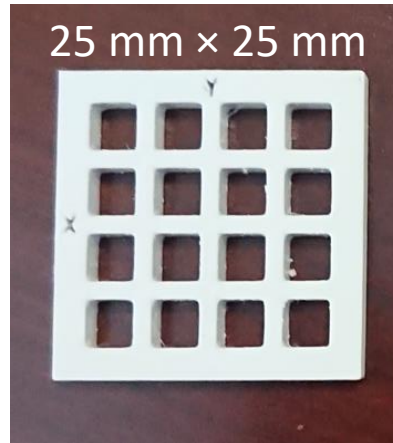
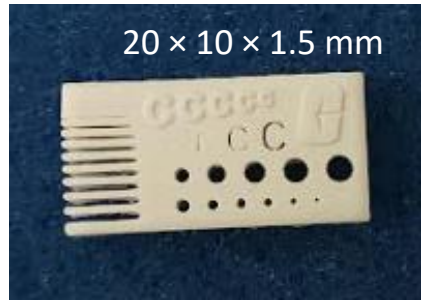
### Training

- 1 Zoom complete,
- One scheduled



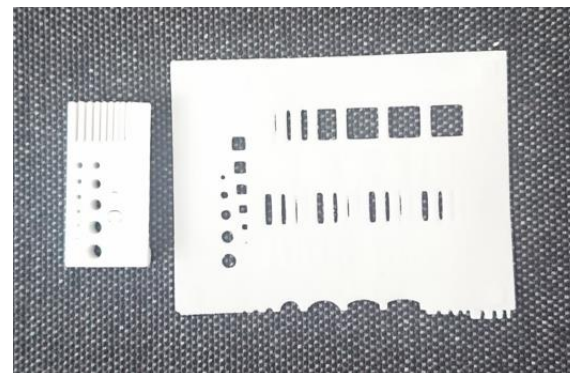
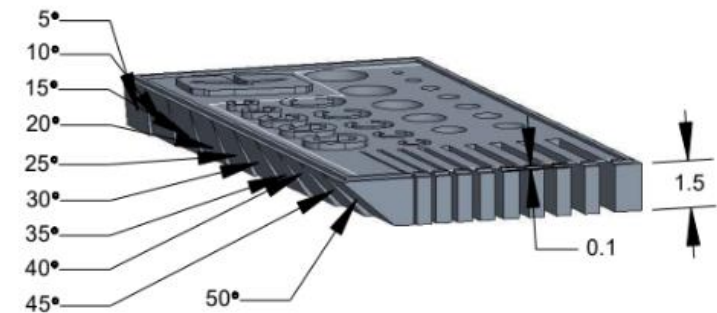
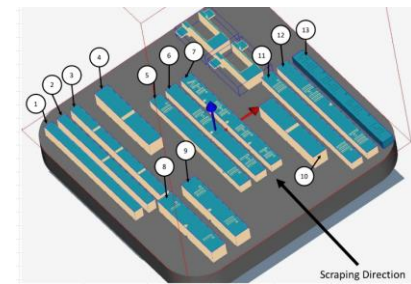
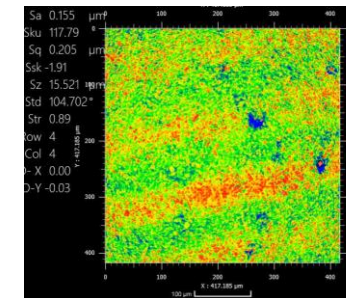
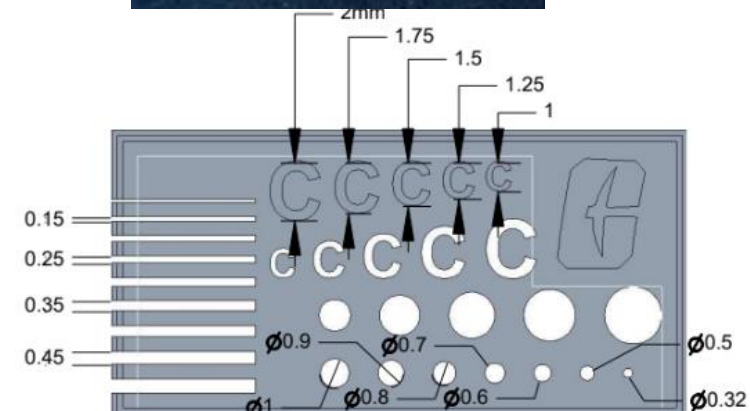
*Build tray up*



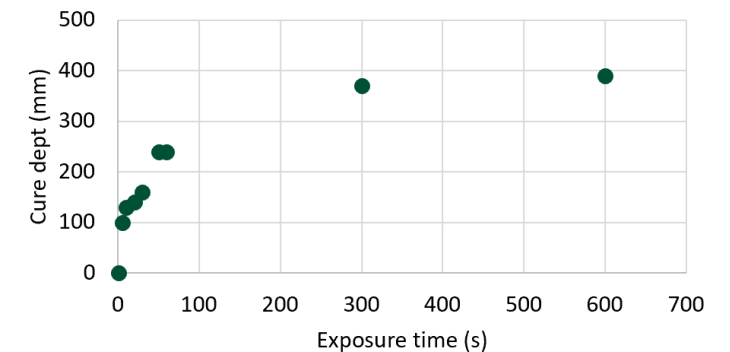


## Printer Familiarity

- Test piece generation
- Application pieces
- Printing test logistics



CureDepth ( $\mu\text{m}$ )



## 3DCeram C100



### Specs:

- Debinding
- Up to 1200 °C
- N<sub>2</sub> atmosphere

## SentroTech: High Temp. Furnace



### Specs:

- 1800 °C
- 4"W x 4"H x 5"D
- Programable Controller
- Pt20Rh/Pt40Rh, (Platinum - Rhodium)
- N<sub>2</sub>/Ar purge kit



### Cleaning station:

- Green state cleaning
- Residue slurry removal



### Centrifugal mixers:

- Thinky ARE-310 – 310 g capacity
- The centrifugal force of over 400G enables simultaneous processing of mixing, dispersion, and deaeration of various materials from low to high viscosities for general purposes.



### Ball mill system:

- 4x500ml Gear-Drive 2-Liter Planetary Ball Mill
- Homogenizing and mixing of powders



## Application and selection process

At least 3 weeks before the planned travel, send a one-page document detailing the trip and reason etc. to [bamullan@uncc.edu](mailto:bamullan@uncc.edu)

- More details can be found via <https://camac.charlotte.edu/>
- Applications can be submitted at any time and are subject to availability of funds.

## Completed Travel:

- **Presentation:** SLA-based Additive Manufacturing of 3D Structures with Surface Activated Silicone Carbide-polymer Composite', M. M. Towfiqur Rahman, Ahmed El-Ghannam, Erina Baynojr Joyee, **The Materials Science & Technology (MS&T22)**, in Pittsburg, PA
- **Visit:** NCSU - Mullany
- **Visit:** ORNL - Mullany, Schmid, Chen, Joyee, Barret-Cirvch, Herd
- **Visit:** Siemens Charlotte - Mullany, Cherukuri, Falaggis, El-Ghannam, Joyee, Chen

Updated version available at  
<https://camac.charlotte.edu/>



11:15 -11:20	General CAMAC updates – Mullany Equipment Updates - Schmid
11:20 – 13:00	Current Project Updates:
11:20- 11:40	“3D printing/Additive manufacturing of photocurable silicone carbide-polymer composite with densified microstructures” - <b>Raham/Joyee/ El-Ghannam (UNCC)</b>
11:40- 12:00	“Discrete Element Method Analysis of Ceramic Powders for Advanced Manufacturing” – <b>Shenouda / Abu-Ledbeh (NC A&amp;T)</b>
12:00-12:20	“Stereolithography of Silicon Carbide” – <b>Herd/Schmid/Mullany (UNCC)</b>
12:20-12:40	“3D Printing of Ultra-High Temperature Ceramics (UHTCs) using Selective Laser-induced Reaction Sintering (SLRS) Process” – /Xu/Fang (NC State)
12:40- 13:00	“Correlating Component Integrity with Surface Characteristics at Each Stage of Ceramic AM Manufacturing” – <b>Andrews/Allen/Mullany (UNCC)</b>
13:00- 13:10	<i>Application update:</i> “Ceramic AM for micro-scale flexural devices” – S. T. Smith (UNCC)- given by Mullany
13:10-13.10	Wrap up and Next steps
13:15	Adjourn Zoom – Head to Duke to tour the facilities

### Seed funding

- Written proposals to be submitted **Friday April 14<sup>th</sup> 2023**
- Idea presentation on **Friday April 21<sup>st</sup>** (Zoom event) ...does this clash with anything major?
- Notification – Early May 2023
- Details can be found here - <https://camac.charlotte.edu/funding-opportunities>

### Spring Meeting

- Project updates and more ...
- Proposed date **Friday May 26<sup>th</sup> 2023** ... does this clash with anything major?