

Center for Additive Manufacture of Advanced Ceramics (CAMAC)

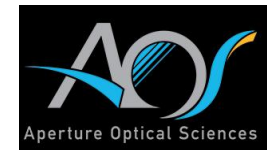
December 5th, 2023

<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



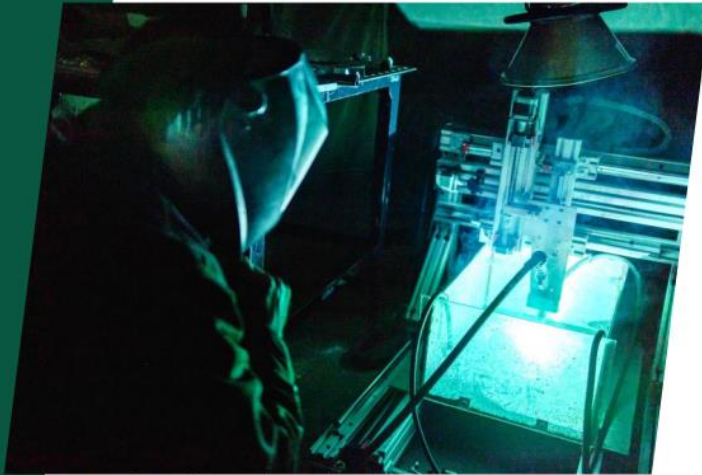
○ CAMAC Infrastructure

- Equipment updates to follow
- Proposals submitted.
- ...

○ CAMAC Sustainability

- Go beyond ROI grant life span ...

Metal Additive Manufacturing @ Charlotte



Cr: Dr. Christoph Kossack, Teaching Asst. Prof.



Metal AM Quick Facts

- ◆ UNC Charlotte is an America Makes Member
- ◆ Expertise in high-temperature superalloys



Mahmoud Dinar, Ph.D. | Asst. Professor
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- ◆ Machine learning process capability
- ◆ Volumes partitioning algorithms
- ◆ Creative design

Key equipment

AM machines

- ◆ EOS M290 (LPBF)
- ◆ EOS M280 (LPBF)
- ◆ Robotic WAAM

Process monitoring systems

- ◆ Phase3D fringe projection system

Powder characterization

- ◆ Dynamic image particle analysis
- ◆ Helium pycnometer

Metals characterization

- ◆ Scanning electron microscopy
- ◆ Electron backscatter diffraction
- ◆ Transmission electron microscope
- ◆ X-ray Diffraction
- ◆ Nano-indenter & Vickers hardness
- ◆ Uniaxial tensile load frames

Simulation capabilities

- ◆ Flow 3D
- ◆ COMSOL Multiphysics
- ◆ ANSYS
- ◆ ABAQUS



Jaime Berez, Ph.D.
Asst. Professor
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- ◆ Qualification for AM
- ◆ XCT
- ◆ Metrology for AM



Ali Bonakdar, Ph.D.
Assoc. Professor
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- ◆ Metal AM
- ◆ Adv. manufacturing
- ◆ Gas turbine applications



Youxing Chen, Ph.D.
Asst. Professor
yuchen103@charlotte.edu

- ◆ Materials analysis
- ◆ Laser remelting
- ◆ Small-scale mechanics



Marjan Molavi-Zarandi, Ph.D. | Assoc. Prof.
mmolaviz@charlotte.edu

- ◆ Metal AM simulation
- ◆ Design for AM
- ◆ Topology optimization

Machining and Surface Treatment @ Charlotte



Source: roslerblog.com



Source: 3Dnatives.com

Machining & Surface Treatment

- ◆ UNC Charlotte is an America Makes Member
- ◆ Expertise in advanced machining and surface treatments:
 - High speed and 5-axis machining, laser polishing, abrasive and hybrid processes
- ◆ Finishing metal additive parts & composites
- ◆ Connections to aerospace and energy industries
- ◆ Members of CPM and CAMAC

Key equipment

Machining

- ◆ 5-axis DMG Mori milling center
- ◆ Makino a51nx 4-axis milling center
- ◆ Milltronics SL8-II turning center
- ◆ Robot machining/AM for repairing*
- ◆ Abrasive Flow Machining*
- ◆ Robot-assisted electrochemical-abrasive finishing*

Surface treatments

- ◆ Laser polishing
- ◆ Forge Fix Air hammer peening*

Hybrid Processes*

Surface characterization

- ◆ Scanning electron microscopy
- ◆ Electron backscatter diffraction
- ◆ Transmission electron microscope
- ◆ X-ray Diffraction
- ◆ Nano-indenter & Vickers hardness

Modeling & simulations capabilities:

- ◆ ABAQUS
- ◆ LS-Dyna
- ◆ SFTC Deform
- ◆ MasterCAM
- ◆ NX for manufacturing*
- ◆ MachPro and CutPro*

*Equipment being sourced



Jose Outeiro, Ph.D. | Prof.

jc.outeiro@charlotte.edu

- ◆ Machining
- ◆ Mech. surface treatments
- ◆ Modeling & Digital Twins



Brigid Mullany, Ph.D. | Prof. & Assoc. Dean for Research

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- ◆ Abrasive finishing
- ◆ Surface classification



L. Taner Tunc, Ph.D. | Assoc. Prof.

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- ◆ 5-axis milling
- ◆ Machining dynamics
- ◆ Tool path generation



Youxing Chen, Ph.D. | Asst. Prof.

yichen103@charlotte.edu

- ◆ Microstructure Design
- ◆ Laser-related manufacturing
- ◆ Small-Scale mechanics

Last meeting

- **June 2023: Hybrid format:** In-person and zoom
 - Project updates and Lab tour

Past meetings

- **April 2023:** New project proposals
- **November 2022:** Project Updates
- **July 2022:** New project proposals
- **May 2022:** Project updates
- **November 2021:** New project proposals
- **October 2020:** The Ceramics Additive Manufacturing Workshop (precursor to CAMAC)

1. Additive Formation of Ordered Ceramic Nanocomposites using Selective Laser Melting
2. A Self-Healing UHTC-reinforced Composite using Selective Laser-induced Reaction Sintering (SLRS) Process for High-Temperature Thermal Stability
3. Stereolithography of SiC for advanced manufacturing for materials for Harsh
4. Correlating Component Integrity with Surface Characteristics at Each Stage of Ceramic AM Manufacturing
5. Direct Ink Writing of SiC/C Ceramic Matrix Composites
6. Additive Manufacturing of High-Entropy Ceramics: Next Generation Ultra-high Temperature Ceramics
7. Stereolithography of Silicon Carbide
8. 3D printing/Additive manufacturing of photocurable silicone carbide-polymer composite with densified microstructures
9. 3D Printing of Ultra-High Temperature Ceramics (UHTCs) using Selective Laser-induced Reaction Sintering (SLRS) Process
10. Discrete Element Method Analysis of Ceramic Powders for Advanced
11. Spatial Analysis of Additively Manufactured Ceramic Surfaces



A Request:

Let us know of any papers/presentations/proposals (funded or not) resulting from your work

Email: bamullan@charlotte.edu

Application and selection process

At least **3 weeks before the planned travel**, send a one-page document containing the following information to the Center Director.

- Names of those travelling
- Destination (must be domestic - no international travel)
- Reason for travel and expected outcomes
- Details of the requested budget

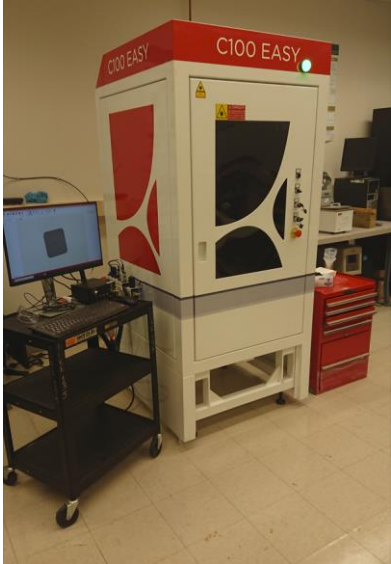
Travel must be related to CAMAC

- Conference presenting CAMAC related work
- Visiting National Labs or Industry to discuss ceramic-based work
- ...

Deliverables:

Upon return from travel, a **brief report of the activities must accompany the submission of the travel receipts.**

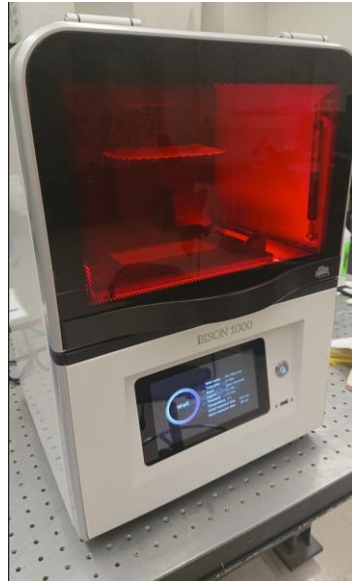
3DCeram C100



Specs:

- Photopolymerization
- UV @405 nm
- Laser spot ~50 μ m
- Build: 100×100×150 mm

Bison 1000



Specs:

- Photopolymerization
- UV @405 nm
- Digital light projection
- Build: 110 × 60 × 138 mm

3DCeram MAT



Specs:

- Polymer metal/ceramic filament
- Fused Filament Fabrication
- Machining head included
- Build: 200 × 200 × 200 mm

Other

3D Potter 10 Pro (Extrusion)

- Build: 415 × 405 × 500 mm

Prusa SL1S Speed (SLA)

- Build: 250 × 210 × 201 mm

3DCeram C100



Specs:

- Debinding
- Up to 1200 °C
- N₂ atmosphere

SentroTech: High Temp. Furnace



Specs:

- 1800 °C
- 4"W x 4"H x 5"D
- Programmable Controller
- Pt20Rh/Pt40Rh, (Platinum - Rhodium)
- N₂/Ar purge kit

Cleaning station:

- Green state cleaning
- Residue slurry removal

Feedstock preparation

- Thinky ARE-310 – 310 g capacity
- ACROSS PQ-N2 planetary ball mill

Analytical tools

- Zetasizer Ultra Blue
- Ohaus precision weighing scale (200 g x 0.0001 g)
- Metrology equipment accessible via the [Center for Precision Metrology](#)



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



December 5 th	Zoom link: sent via mail/calendar invite
	Room Location: Room 106, Duke, UNC Charlotte
12:00 - 12:30	Coffee/snacks, presentation uploads, etc.
12:30 – 12:40	Welcome & CAMAC updates - <i>S. Schmid (UNC Charlotte)</i>
Start Technical Session	
12:40 – 13:00	Additive Formation of Ordered Ceramic Nanocomposites using Selective Laser Melting– <i>Aidan Restelli/H. Zhang (UNC Charlotte)</i>
13:00 -13:25	Correlating Component Integrity with Surface Characteristics at Each Stage of Ceramic AM Manufacturing – <i>Sarah-Margaret Andrews/ A. Allen & B. Mullany (UNC Charlotte)</i>
13:25-13:45	3D Printing of Ultra-High Temperature Ceramics (UHTCs) using Selective Laser-induced Reaction Sintering (SLRS) Process - <i>Kaushik N. Vinod & Shalini Rajpoot/ C. Xu & T. Fang (NC State)</i>
13:45-14:05	A Self-Healing UHTC-reinforced Composite using Selective Laser-induced Reaction Sintering (SLRS) Process for High-Temperature Thermal Stability - <i>Shalini Rajpoot & Kaushik N. Vinod / C. Xu & T. Fang (NC State)</i>
Quick Break	
14:20 - 14:45	Direct Ink Writing of SiC/C Ceramic Matrix Composites – <i>Trevor Williams/Y. Chen & E. Joyee (UNC Charlotte)</i>
14:45 - 15:10	Stereolithography of SiC for advanced manufacturing for materials for Harsh Environments – <i>Tien Herd/ S. Schmid (UNC Charlotte)</i>
15:10 – 15:25	Ceramic AM for the manufacture of monolithic flexure mechanisms (externally funded via CPM)- <i>Anand Rathnam/ S. Smith (UNC Charlotte)</i>
15:25 – 16:00	Funding calls/ sustainability discussion & wrap up

TRL 1-2.5

External Funding Calls

- NSF - [Advanced Manufacturing](#) program
- ARL - [Super-Materials Research in support of the Sciences of Extreme Materials Competency](#)
- ARL - [Advanced Manufacturing Research in support of the Sciences of Extreme Materials Competency](#)

TRL 3-5

Center for Freeform Optics (open to UNC Charlotte faculty)

- Call over the summer months – optical applications (mirrors, molds, ...)
- CeFO [Website](#)

Any TRL

Funded research – contract with faculty

- **Grad student over the 3 Summer months** (no tuition or fees)
 - ~\$18.5k (research)
- **Grad student for Academic year** (12 months, tuition & fees):
 - ~\$72k (research)



Spring 2024

- **Suggestion:** Industry- Academia Symposium and Networking day -
 - Held annually
 - Showcase work
 - Seek collaborators
- **Suggestion:** Ceramic Additive Manufacturing educational media content – proposals will be accepted in Jan 2024
 - \$5,000 will be awarded/ proposal
 - 2-3 awards anticipated
 - Educational videos
 - Modules for conventional course structures
 - Additive Ceramics for Energy applications
 - ...
- **Other suggestions:** ...

ONLINE
WEBINAR

SAVE
THE
DATE



The Bioceramic Revolution: 3D Printing from Blueprint to Bedside

December 13, 2023 | 4:00 PM (CET) | Teams

Join the webinar:



Up Coming Webinar

Join the webinar:



SPEAKERS BIOS



Gregory Nolens
CSO (Chief Scientist
Officer) at Cerhum

Grégory is the founder of Cerhum, a company specializing in 3D printing of synthetic bones. He is a highly skilled professional with a PhD in Biomedical Sciences and expertise in advanced manufacturing, medical device development, and regulatory affairs.



Arnaud Roux
Sales Representative
at 3DCeram

Arnaud Roux is responsible for European sales at 3DCeram Sinto, specializing in Ceramic 3D printing. He obtained a Master's in International Business Management in France and a Bachelor's in Business Administration in Scotland, and joined the company in 2016.



www.3dceram.com

Join the webinar:



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