

Automation of MTC for High Temperature Ceramic Filters

Team W.E.G.



U.S. DEPARTMENT OF
ENERGY

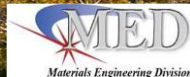
Energy Efficiency &
Renewable Energy



William Hochstedler

Eduardo Ramirez

Gabriel Peters



Introduction



Eduardo A.
Ramirez

University:
UTEP
Major:
Mechanical
Engineering

Bio:

I am currently pursuing my M.S. with an interest in additive manufacturing and aerospace.



Gabriel J.
Peters

University:
Purdue
Major:
Aerospace
Engineering

Bio:

I am a rising senior who loves working on impactful projects, designing models, and rocketry.



William M.
Hochstedler

University:
FSU
Major:
Mechanical
Engineering

Bio:

I am a recent M.S. graduate exploring opportunities in automation and device development.

Background Info



Problem: High nuclear facility cost to maintain safety

Destroyed filter bank after a fire

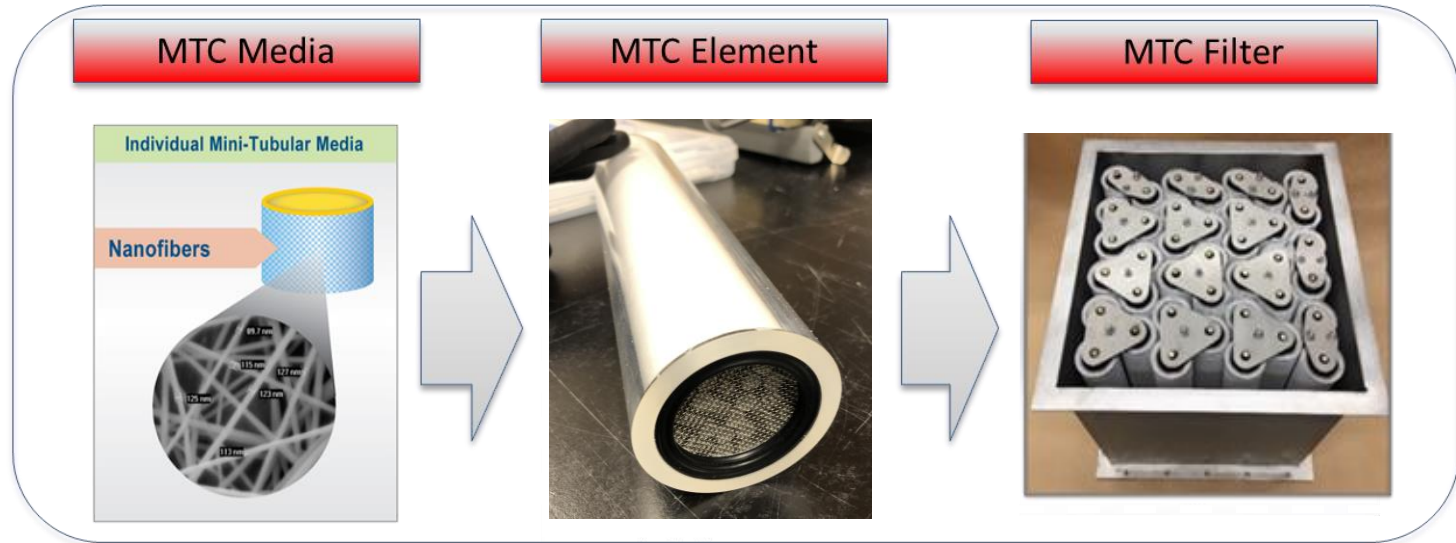


Water damage to filters following a fire



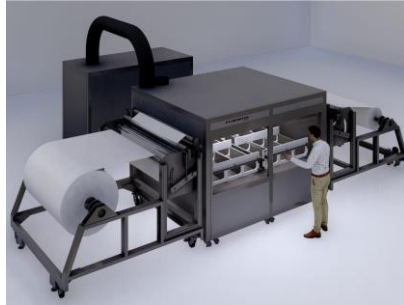
Ceramic filters perform at higher temperatures and are likely to eliminate reliance on credited fire suppression systems

Solution: MTC HEPA filters based on ceramic nanofibers



- What are MTC's? 
 - Tiny Ceramic Filter Media
 - Many, many are needed for a single MTC filter

The Process



1. Electrospinning



Bottleneck!



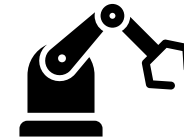
2. MTC Forming



3. Constructing



AUTOMATION

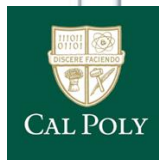
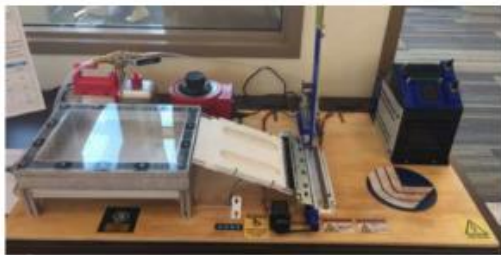
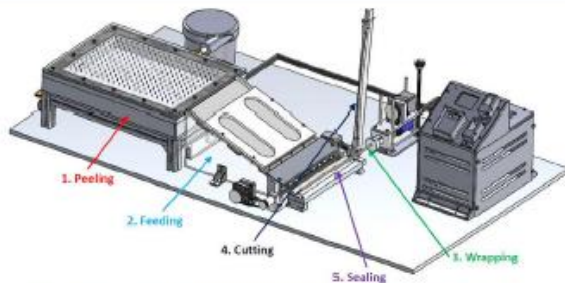


Principle Investigation

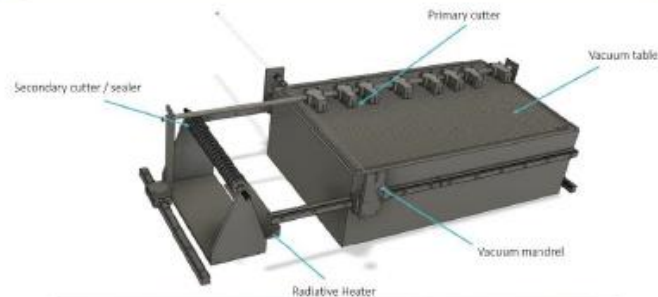


Earlier Prototypes of MTC Forming

First Generation Prototype



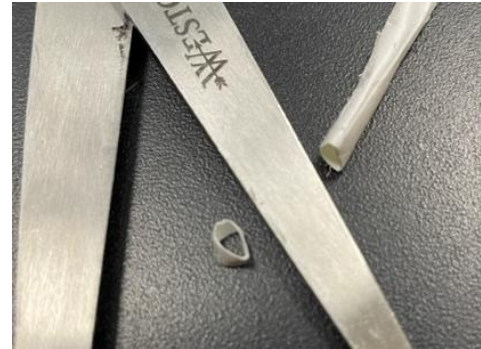
Second Generation Prototype



Progress has been made, but further improvements are still needed

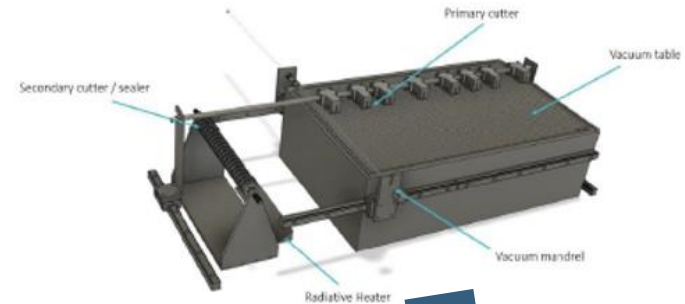
Challenges

- Nanofibers are delicate, dissolvable, corrosive, and oxidizing
- Mandrel adherence is atypical
- Heat sealing causes shrinking
- Single layer MTC's lack structural integrity



Goals

1. Process is semi (or fully) automatic
2. MTC production is scalable
3. 10-100 media made per minute
4. Safe for an operator to use/clean
5. 80% of MTC made are useable
6. Fits within 2x1m of space
7. Mesh is wrapped 1-4 times
8. Cylinders have 4mm diameter, 4mm height

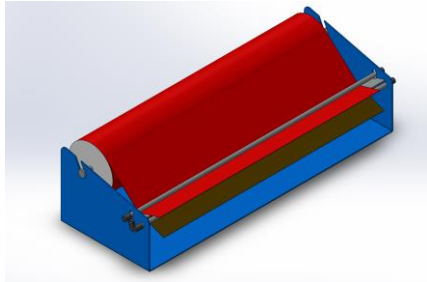


W.E.G. Prototype

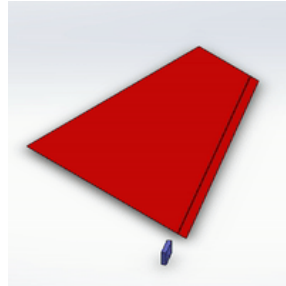
Automation



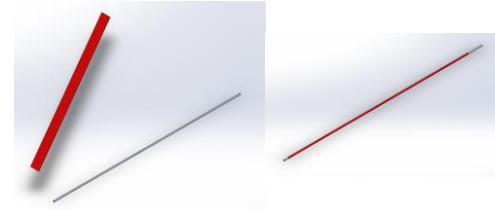
Several Steps!



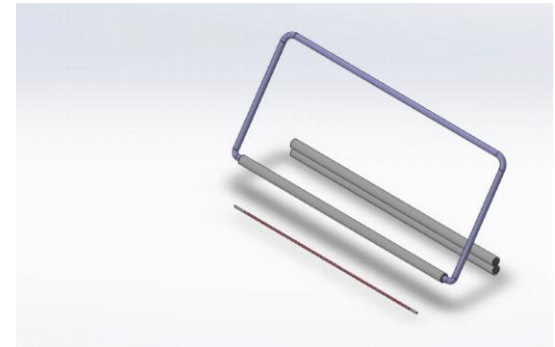
1. Separate backing



2. Cut into strips



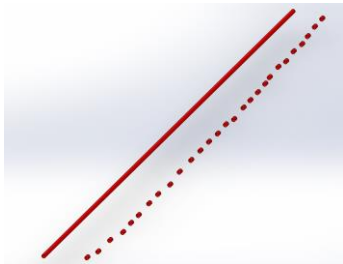
3. Attach to mandrel



4. Roll mesh into shape



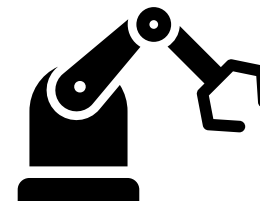
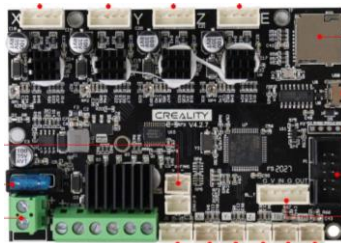
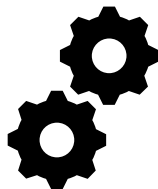
5. Remove mesh "straw"



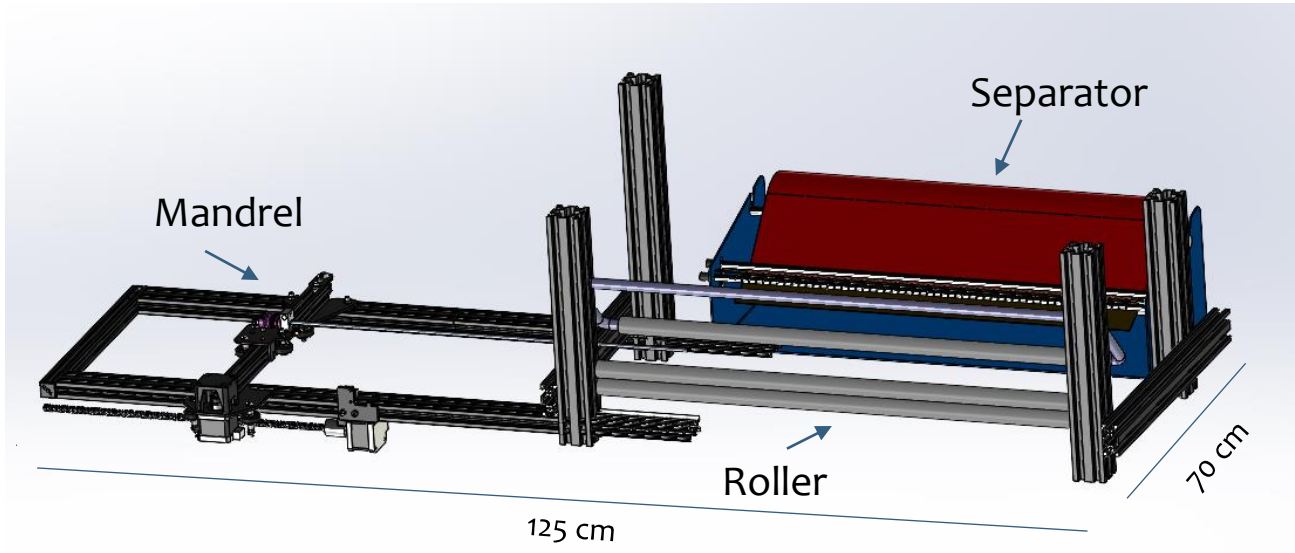
6. Dice into MTC

Automation/Robotics

- Every step automated from electrospun nanofiber mesh sheets to MTC
- 11 motors, 8 sensors, a repurposed 3D printer framework and reprogrammed motherboard, and hours of coding



Current Design



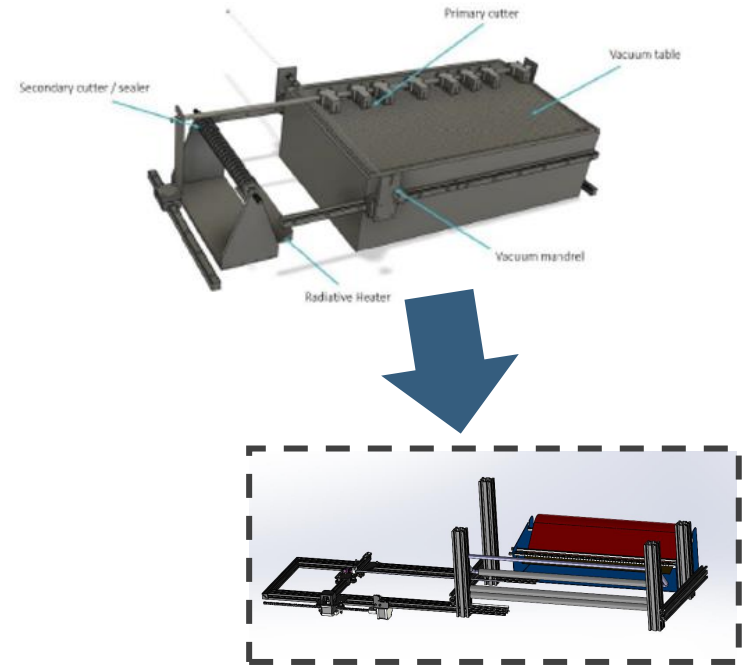
Cutter
(not shown)

Conclusions



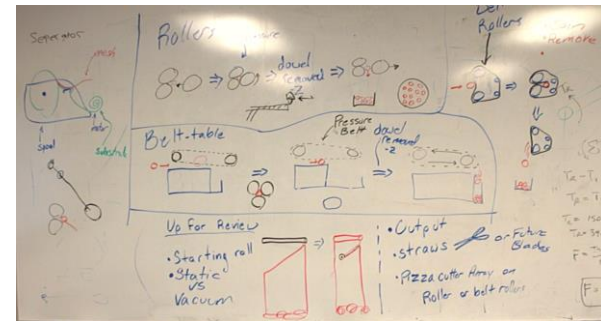
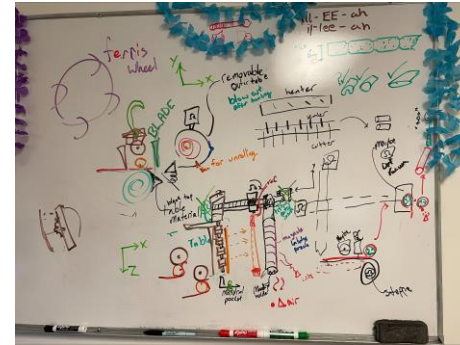
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Next Steps

- Order electronics
- Design mounts
- Design cutting apparatus
- Design straw dicing system
- Complete 3D models
- Build prototype
- TEST, TEST, TEST
- Validate final media

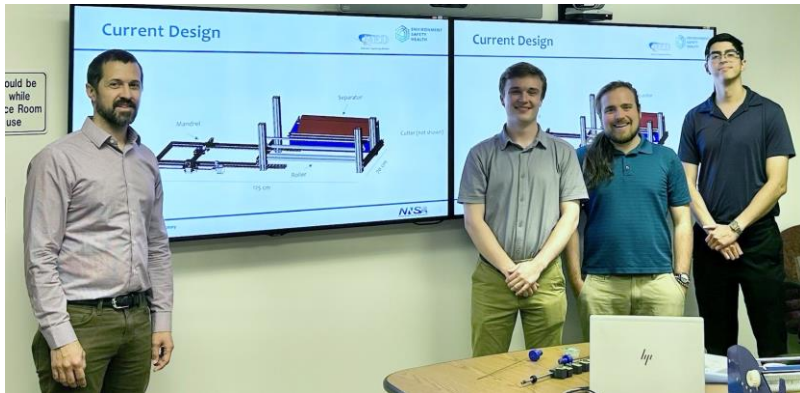




Acknowledgements

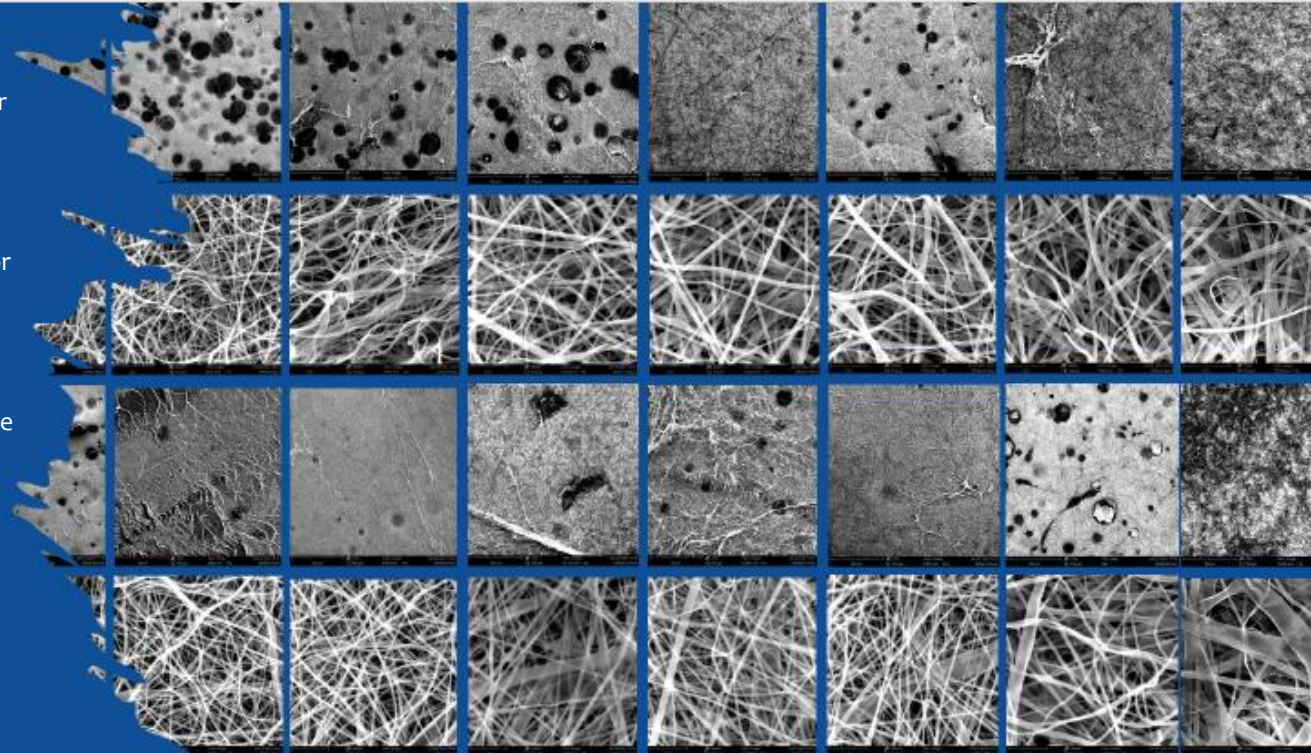


- CHRES and NNSA MSIPP
- NNSA MSIP, DOE-EERE AMMTO, ORISE
- LLNL, ES&H, MED, NSR&D
- Special thanks to our mentors!





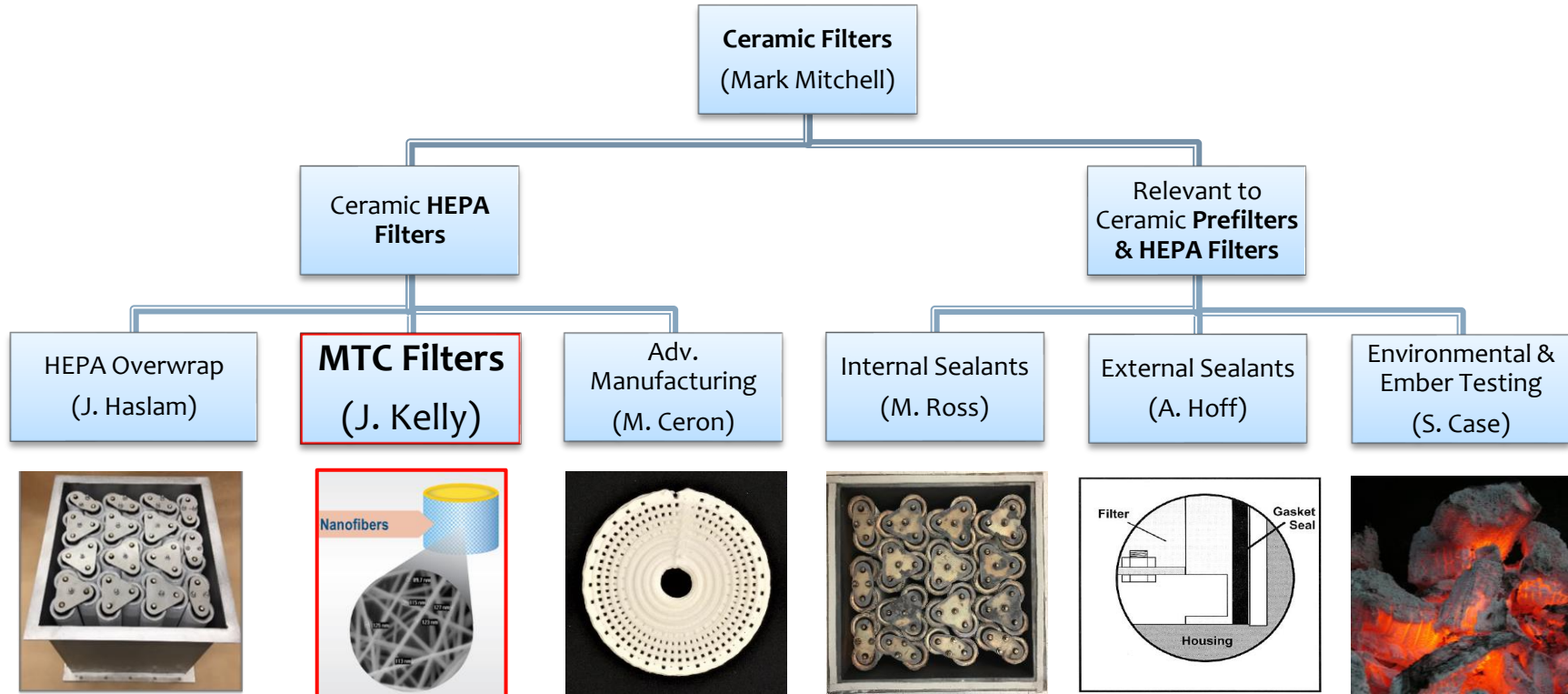
This research was performed under an appointment to the Minority Serving Institutions Internship Program (MSIIP) administered by the Oak Ridge Institute for Science and Education (ORISE) for the National Nuclear Security Administration (NNSA) and U.S. Department of Energy (DOE). ORISE is managed by Oak Ridge Associated Universities (ORAU). We would also like to thank the DOE Office of Energy Efficiency & Renewable Energy. All opinions expressed in this paper are the author's and do not necessarily reflect the policies and views of NNSA, DOE, ORISE or ORAU.



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Overview of LLNL ceramic filter development



OBJECTIVE: To develop MTC HEPA filtration media forming methods and process equipment that automates otherwise laborious manual operations.

