NanoSonic, Inc.
nanotechnology at work

3D Printed Bimetallic Structures for Radio Frequency Devices

PI: Jennifer Lalli

2024 SBIR/STTR Exchange PI Meeting

August 13-15, 2024

Sponsored by the Department of Energy Office of Science, Office of Nuclear Physics

August 13, 2024
3:10 PM
DOE SBIR Phase II NP SBIR Exchange

TPOC: Dr. Michelle Shinn

NanoSonic, Inc.
nanotechnology at work

Small Advanced Materials Company
- Incorporated 1998
- Green development and scaled production
- Polymers, composites, and sensors
- Commercialized >15 SBIR derived technologies

Wheatland EcoPark, in Pembroke, VA
LEED certified, energy-efficient, green building

Overview

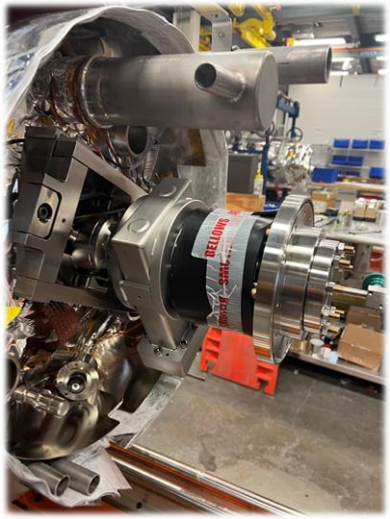
Topic 34a: Materials and Components for Radio Frequency Devices

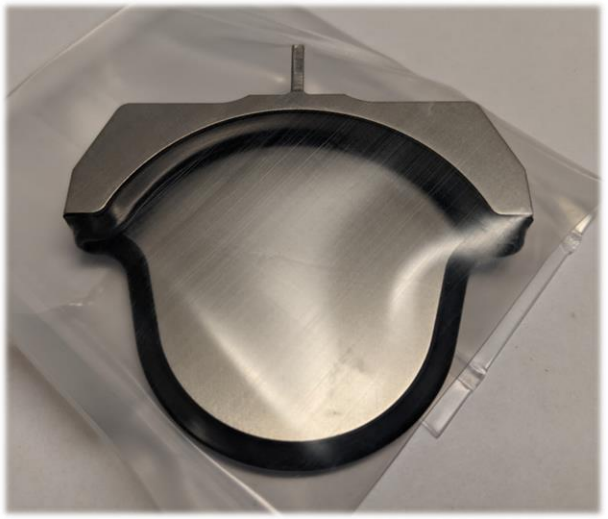
Needed for Particle Accelerators:

- Improve components within superconducting RF (SRF) devices
- Bimetallic materials to reduce electron beam welds
- Radiation durable gate valve seals for cryomodules
- Continuous Electron Beam Accelerator Facility (CEBAF) at the Thomas Jefferson National Accelerator Facility (TJNAF)

Partners:

- **Jefferson Lab**
- **BNL NSRL and VPT Rad**
- **Virginia Tech - AM**
- **Giles County - PIER**





Advance fundamental accelerator technology and its applications to nuclear physics scientific research

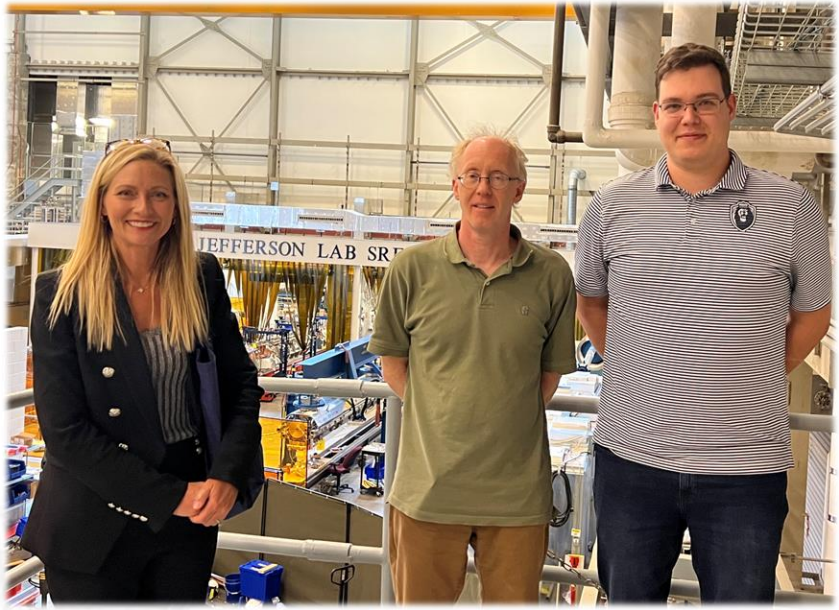
DOE Topic 34a – Materials for RF Devices

Grant #: **DE-SC0022482**

OBJECTIVE:

- Develop high radiation (12 GeV) tolerant seals used in cryomodule gate valves
- 53 Gate Valves at Jefferson Lab replaced ~semi-annually
- New materials for gate valves in cryomodules

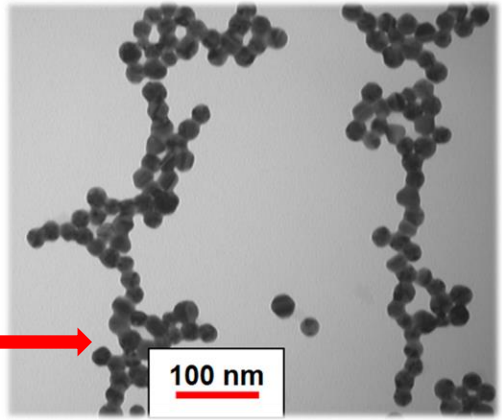
Jefferson Lab



Need Radiation Durable Gate Valve Seals to Decrease Replacement within Jefferson Laboratory's Continuous Electron Beam Accelerator Facility (CEBAF)

ISO 9001:2015 Certified by NSF-ISR

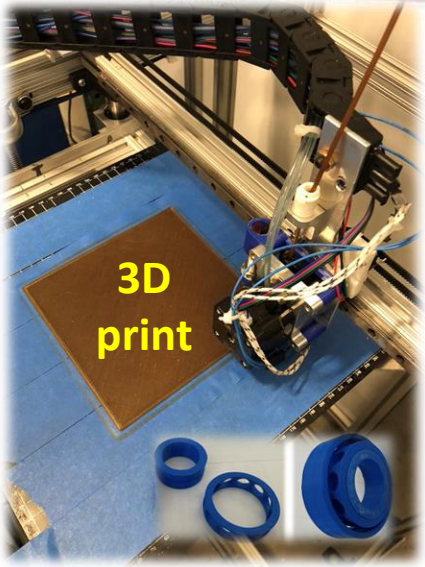
250-gal, 55-gal, 1-10 L in hood, two 20L, and one 100 L reactor

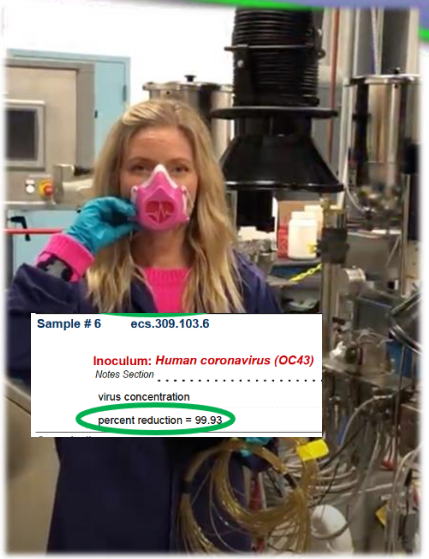


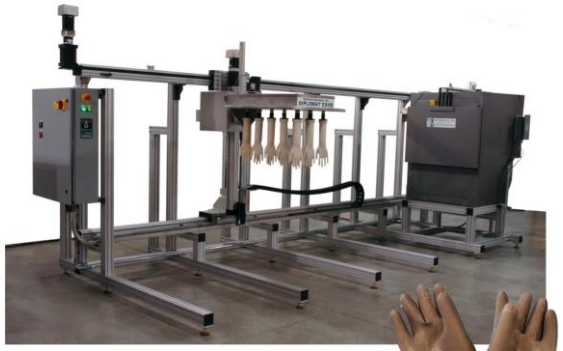
Au from 100 -L

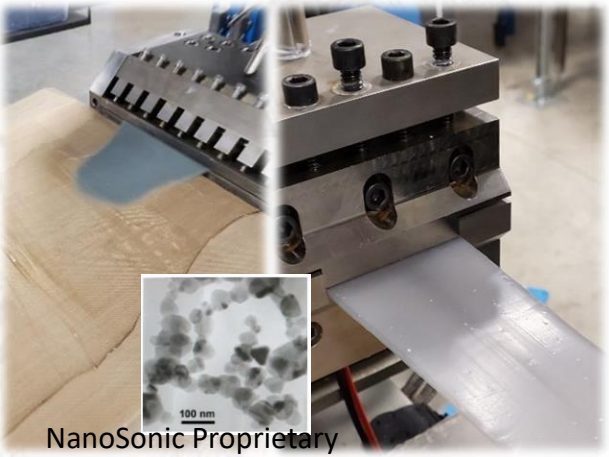
NanoSonic Production Capabilities:

Extrusion and 3D Printing of Radiation Tolerant Polymers, Metals, & Ceramics



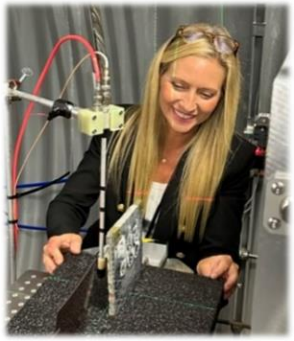






NanoSonic

NanoSonic Team – VT and Jefferson Lab



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AM Lead

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ISO Lead

Mike Bortner
Ph.D. Chem. Eng.
VT AM Group

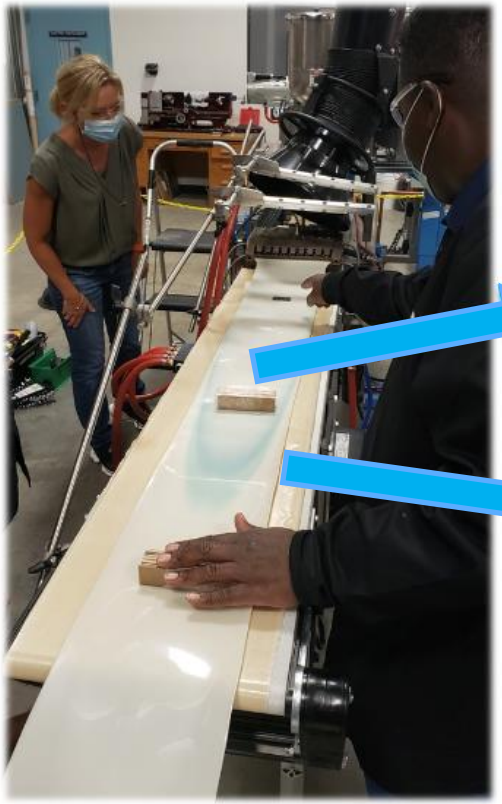
- 2 R&D 100 Awards for HybridSil® & Metal Rubber™ (issued patent)
- Commercialized >15 SBIR product sold through www.nanosonic.com
- Track record of shielding sales to government customers
- New PFAS-free sales current for this year
- Repeatability and scalability
- >20 years of Science Communication
- Post-consumer course

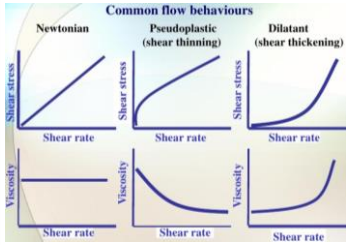
Jefferson Lab

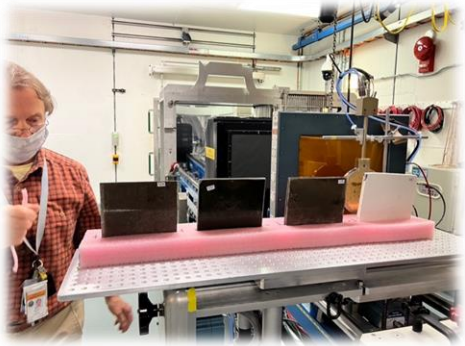
Technical Team: NanoSonic, VT, and Jefferson Lab

Technical Approach:

Produce New Materials for Radiation Exposure and Durability Studies

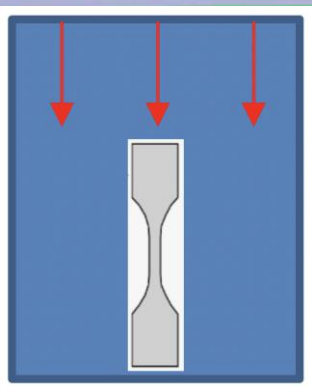
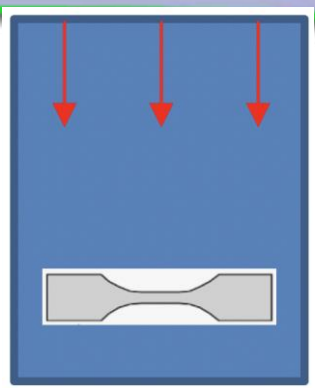
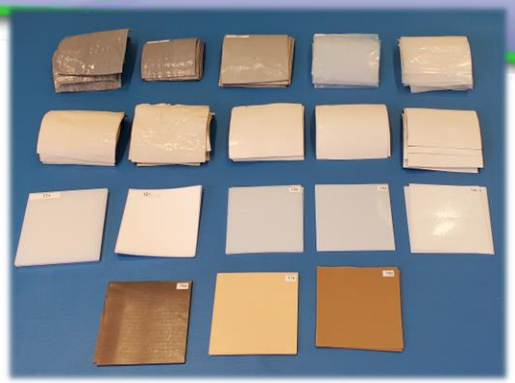




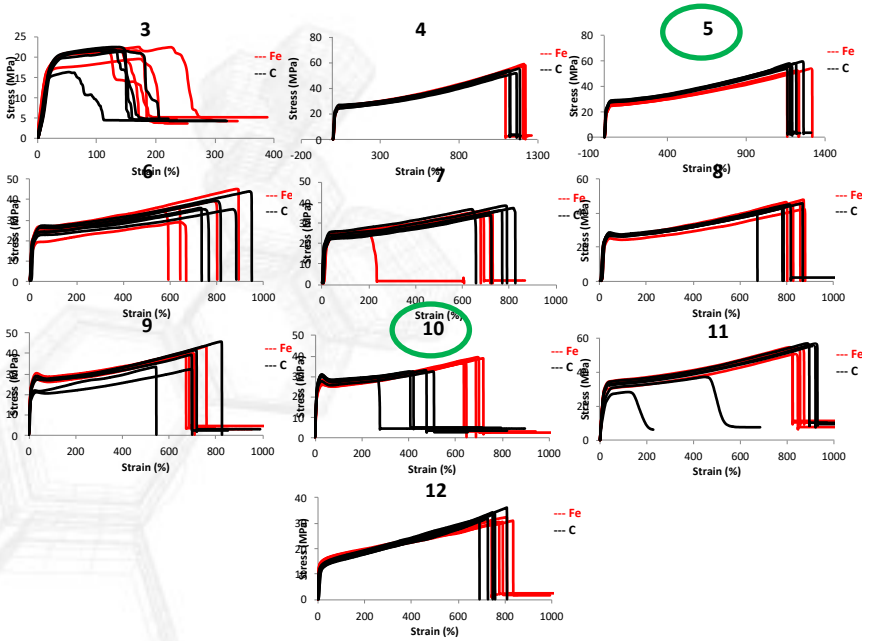


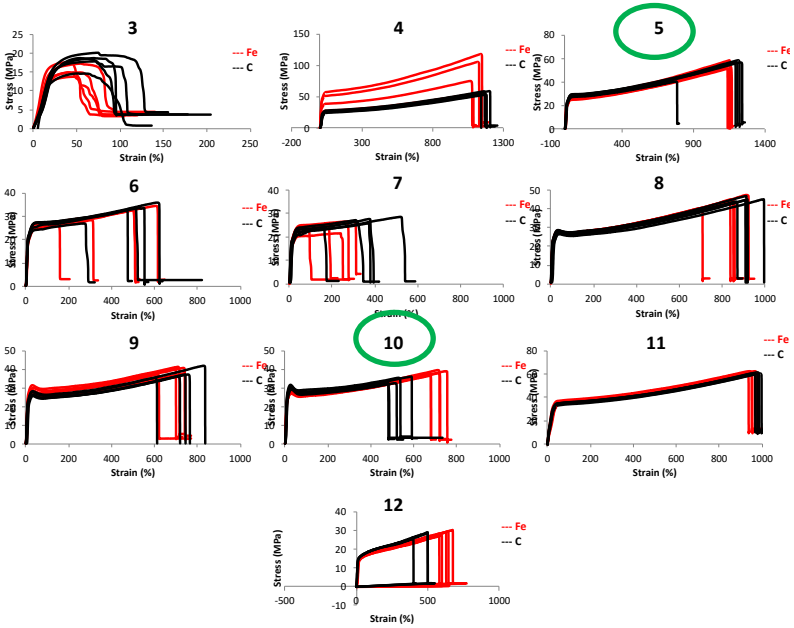
Utilize Scalable Additive Manufacturing Techniques to Develop Materials for Bench Testing Alongside Standards at BNL NSRL

Exposure at NSRL to Fe 1 GeV (214 Gy)
Chain Scission vs. Embrittlement

Mechanical Properties for All NanoSonic Films in Parallel and Perpendicular Directions

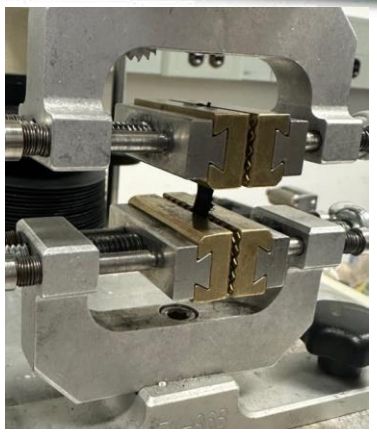


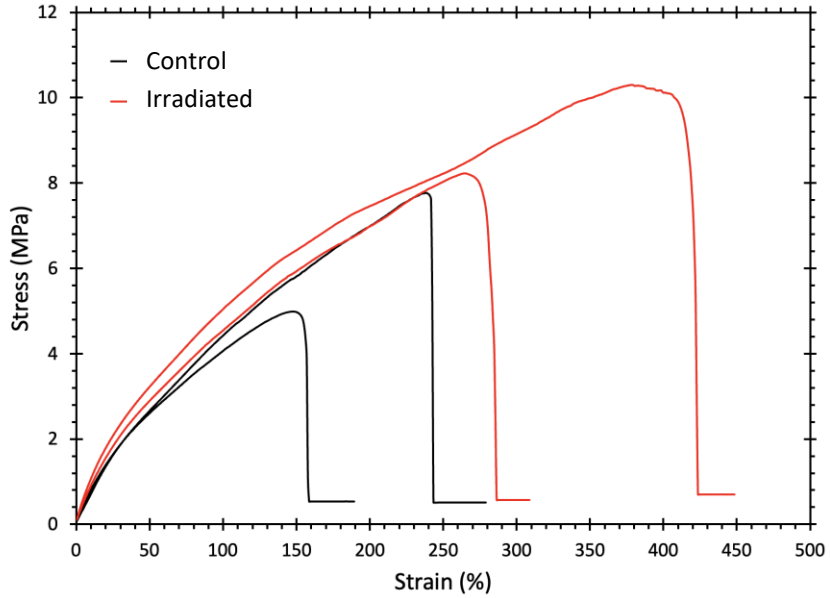


Radiation Exposure 1 GeV Fe (214 Gy)

Technical Approach:

Test Mechanical Properties of New Irradiated Materials Alongside Standard

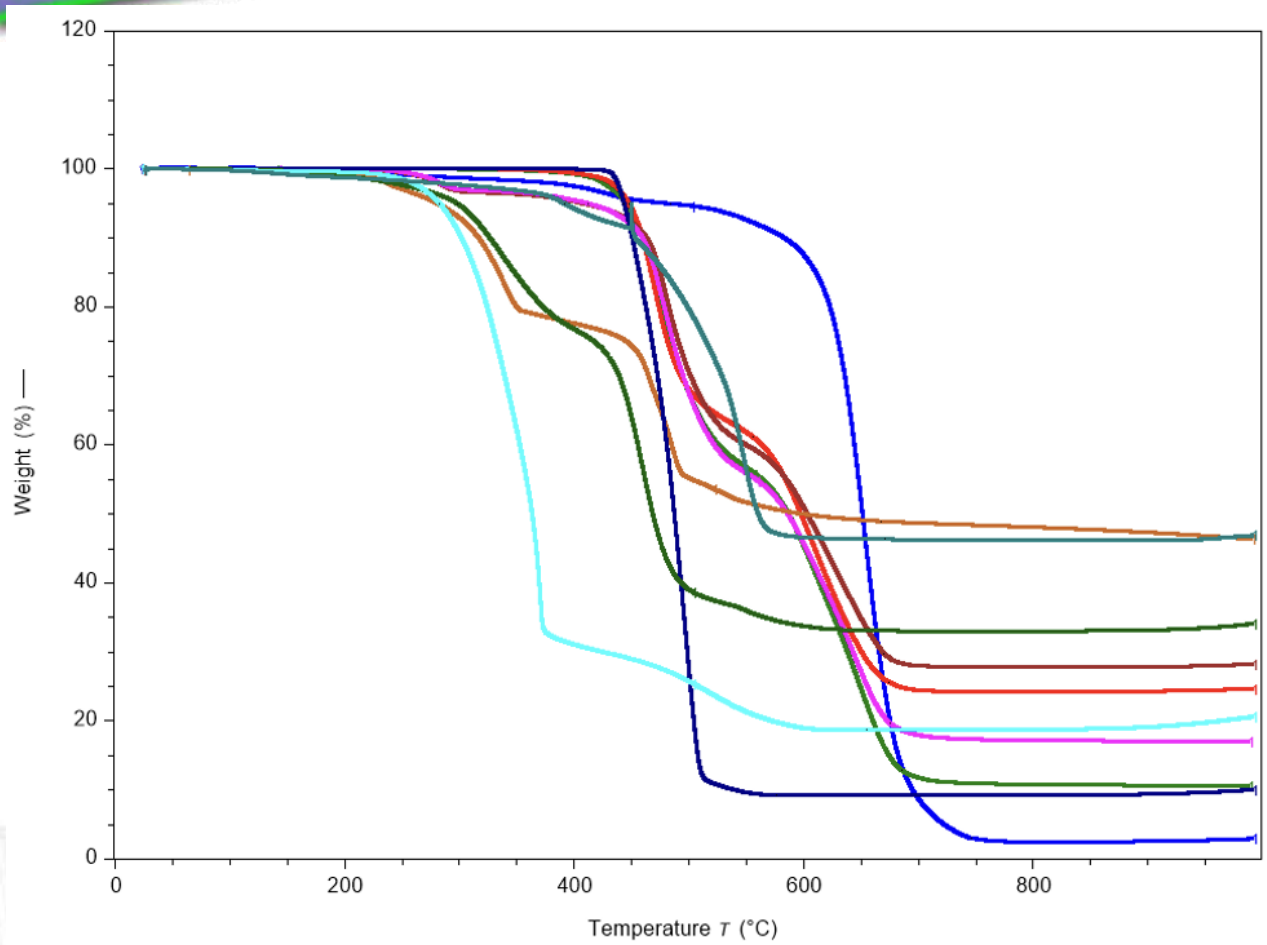


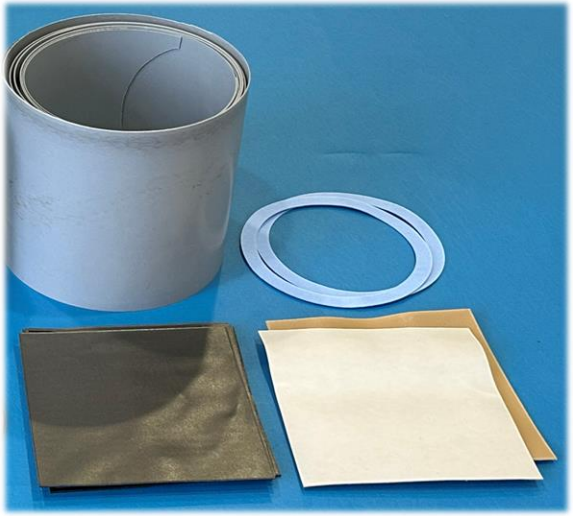


Radiation Exposure of Materials at 1 GeV proton (2 Gy)

Technical Approach:

Test Mechanical Properties of New Irradiated Materials Alongside Standard

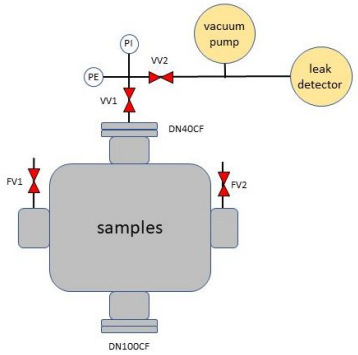


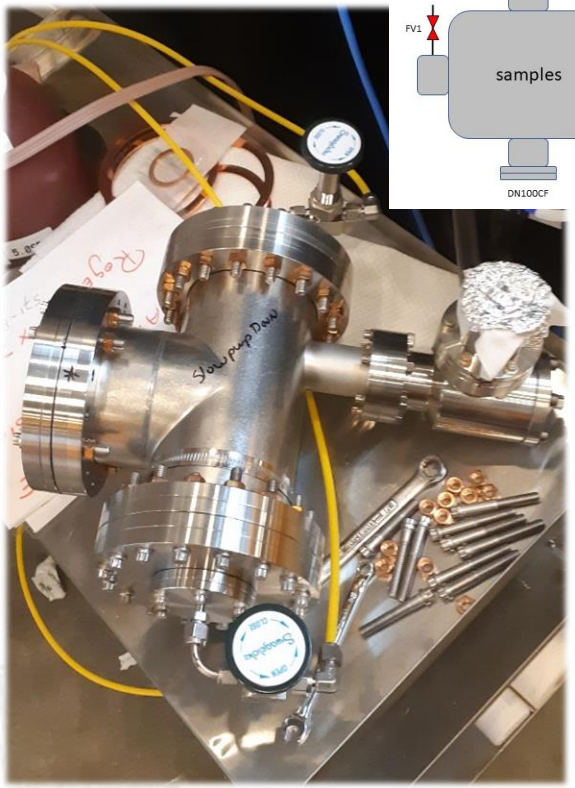


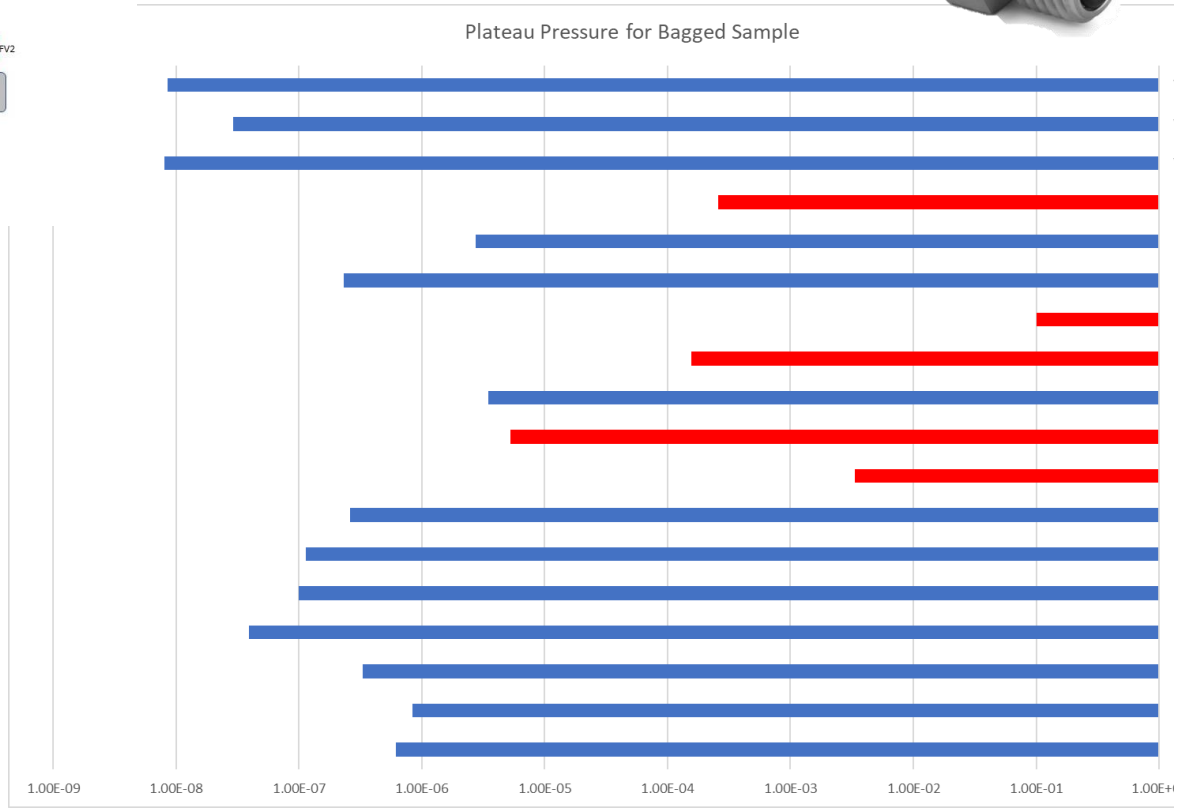
Thermal Stability Characterization via Weight Loss and Char Yield and Down-Selection Prior to Outgassing

Technical Approach:

Test Mechanical Properties of New Irradiated Materials Alongside Standard







Materials Delivered to Jefferson Lab for Out-gassing

Current Status of Seal

Materials Undergoing Extensive Seal Performance Testing and Down-Selection for High Dose Radiation Exposure

Commercial Need Addressed

- ***PFAS-free***
  - Seals
  - CBRN Gloves
  - EPA ban on forever chemicals

U.S. Environmental Protection Agency (.gov)
https://www.epa.gov › newsreleases › biden-harris-admin...

Biden-Harris Administration Finalizes Critical Rule to Clean ...

Apr 19, 2024 — **"President Biden** understands the threat that "forever chemicals" pose to the health of families across the country. That's why EPA launched ...

- ***Radiation and EMI Shielding:***
  - Medical shields
  - First Responder PPE
  - Space systems
  - Nuclear reactors

NanoSonic has sold PFAS-free Gloves and Radiation Shielding that Protect People and Life Critical Application Systems

Acknowledgements

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Jefferson Laboratory

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