Exit Presentation

Kate Melone
12/8/16
Overview

• About Me
  – Education
  – Hobbies and Interests
  – Past Experiences
• Projects
  – Radiated Materials Tensile Testing
  – Outgassing Testing for SHERLOC on Mars 2020 Rover
  – Z2 Support
  – LCVG Flush and Purge Console
• Lessons Learned
• Future Plans
• Acknowledgements
About Me

• Born and raised in Delaware
• I have a cat named Comet
• Dream car: Lamborghini
• Favorite TV Show: Leave It To Beaver
• Space Geek
  – Manned Space Exploration
  – Crew Systems, Orbital Mechanics, Aerodynamics, Propulsion
Education

• University of Maryland, College Park
  – Go Terps!
• Pursuing my B.S. in Aerospace Engineering
  – Concentration in Astronautics
Hobbies and Interests

• Sports
  – Basketball, football, hockey, baseball, soccer

• Music
  – Listening to music and going to concerts

• Family and Friends
  – Spending time with family and friends
Past Experiences: UMD Research and Conferences

• Undergraduate research
  – Analog space suit joint torque elbow testing
  – Development of analog spacesuits
  – Pneuminically powered EVA Glove

• Conferences and Papers
  – AIAA Region 1 Student Paper Conference (Spring 2014, planning to go Spring 2017)
  – AIAA Young Professionals, Students, and Education Conference (Fall 2014 and Fall 2015)
Past Experiences: JSC SK3
Summer 2014 Internship

EVA Glove Sensor Feasibility II Project

• **Goals:** Develop a method and list of sensors for measuring the glove environment acting on the fingers and hands inside the glove box

• **Importance:** Obtain data that can be correlated with astronaut injury reports

• **Accomplishments:** Analyzed extensive amounts of data and assisted in writing the EVA Glove Sensor Feasibility II Report
Past Experiences: JSC EC5
Summer 2015 Internship

RoboGlove Cycle Tester
• **Goals:** Test repeatability and endurance of Force Sensitive Resistors (FSRs)
• **Importance:** Determine whether or not FSRs will suffice for long term use
• **Accomplishments:** Successfully designed and built a cycle tester by the completion of my internship
Tensile Testing of Radiated Space Suit Materials

Outgassing Testing for SHERLOC on Mars 2020 Rover

Z2 Support

LCVG Flush and Purge Console
Tensile Testing of Radiated Materials

• Objective: Tensile test radiated space suit materials
• Purpose: Compare pre/post radiation mass, max tensile load, and max tensile extension
Radiated Materials Tensile Testing

Orthofabric
Teflon
Vectran
Dacron
Spectra
Bladder Material
nGimat Coated Orthofabric
nGimat Coated Teflon
Polycarbonate
• Conducted tensile testing of various radiated materials
  – Prepared samples for testing
  – Set up tests
  – Collected data
Radiated Materials Tensile Testing

• Assembled Test Reports
• Analyzed data and put together a test results summary of total mass loss (TML), fabric appearance, maximum/minimum max load, maximum/minimum max tensile extension

```
<table>
<thead>
<tr>
<th>Specimen</th>
<th>Minimum Load (lb)</th>
<th>Maximum Tensile Extension</th>
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<tbody>
<tr>
<td>1</td>
<td>187.47</td>
<td>0.71</td>
</tr>
<tr>
<td>2</td>
<td>349.12</td>
<td>0.81</td>
</tr>
<tr>
<td>3</td>
<td>472.12</td>
<td>0.85</td>
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<tr>
<td>4</td>
<td>584.34</td>
<td>0.85</td>
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<tr>
<td>5</td>
<td>173.67</td>
<td>0.92</td>
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</table>
```

**NOTES**
- Estimated minimum criterion
- Used various props to help load measurement in proper

![Graph showing tensile testing results](image-url)
Radiated Materials Tensile Testing

Tensile Test Results Takeaways

- High tensile strength, elongation, and modulus values for the material tested.
- Radiated materials exhibit significant improvements in tensile properties compared to control samples.
- Radiated samples demonstrate higher tensile strength and modulus values.
- Radiated samples have lower elongation and modulus values compared to control samples.

Control Results
- Assessed Control Sample: 0.120

Radiated Results
- Assessed Radiated Sample: 0.122

Material: Teflon

Key Tensile Properties:
- Tensile Strength: 30.00 MPa
- Tensile Elongation: 7.84 %
- Tensile Modulus: 2.16 GPa

General Notes:
- Varying values with radiated Teflon similar seen with other materials.
- No Teflon in grade 2 (control).
- Values differ between the control samples due to elongation and modulus values.

Material: Radiated Teflon

- Tensile Strength: 30.00 MPa
- Tensile Elongation: 7.84 %
- Tensile Modulus: 2.16 GPa

General Notes:
- Varying values with radiated Teflon similar seen with other materials.
- No Teflon in grade 2 (control).
- Values differ between the control samples due to elongation and modulus values.

Sample Preparation:
- Samples prepared under standard conditions.
- Samples are conditioned for 24 hours before testing.
- Samples are tested under controlled environmental conditions.

Sample Testing:
- Samples tested under standard conditions.
- Samples are tested under controlled environmental conditions.
- Samples are tested under standard conditions.

Sample Analysis:
- Samples analyzed for tensile properties.
- Samples are analyzed under controlled environmental conditions.
- Samples are analyzed under standard conditions.

Sample Results:
- Samples exhibit higher tensile properties compared to control samples.
- Samples exhibit lower elongation and modulus values compared to control samples.
- Samples exhibit higher tensile properties compared to control samples.
- Samples exhibit lower elongation and modulus values compared to control samples.
- Samples exhibit higher tensile properties compared to control samples.
Radiated Materials Tensile Testing: Summary of Results

<table>
<thead>
<tr>
<th>Material</th>
<th>Mass Difference (g)</th>
<th>Average Max Load Baseline (lbf)</th>
<th>Average Max Load Radiated (lbf)</th>
<th>Average Max Tensile Extension Baseline (in)</th>
<th>Average Max Tensile Extension Radiated (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orthofabric</td>
<td>.0053</td>
<td>335.9</td>
<td>343.4</td>
<td>.410</td>
<td>.238</td>
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<tr>
<td>Teflon</td>
<td>.0053</td>
<td>30.6</td>
<td>24.1</td>
<td>3.76</td>
<td>2.01</td>
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<tr>
<td>Vectran</td>
<td>.0055</td>
<td>464</td>
<td>241</td>
<td>.640</td>
<td>.444</td>
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<tr>
<td>Dacron</td>
<td>.0010</td>
<td>245</td>
<td>105</td>
<td>1.10</td>
<td>.476</td>
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<tr>
<td>Spectra</td>
<td>.0191</td>
<td>1363</td>
<td>1190</td>
<td>14.0</td>
<td>12.0</td>
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<tr>
<td>Bladder Material</td>
<td>.0032</td>
<td>117</td>
<td>100</td>
<td>.85</td>
<td>.50</td>
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<tr>
<td>nGimat Coated Orthofabric</td>
<td>.0061</td>
<td>304</td>
<td>379</td>
<td>1.18</td>
<td>.93</td>
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<tr>
<td>nGimat Coated Teflon</td>
<td>.0006</td>
<td>67.1</td>
<td>51.8</td>
<td>3.32</td>
<td>2.25</td>
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<tr>
<td>Polycarbonate</td>
<td>.0034</td>
<td>1071</td>
<td>1079</td>
<td>.360</td>
<td>.325</td>
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</table>
Tensile Testing of Radiated Space Suit Materials

Outgassing Testing for SHERLOC on Mars 2020 Rover

Z2 Support

LCVG Flush and Purge Console
Outgassing Testing for SHERLOC on Mars 2020 Rover

• SHERLOC
  – Scanning Habitable Environments with Ramen and Luminescence for Organics and Chemicals
  – Will search for organic materials altered by water environments

• Space suit materials will be placed on the SHERLOC calibration target
Outgassing Testing for SHERLOC on Mars 2020 Rover

• Became familiar with and understood contents of the Goddard outgassing database
• Put together database summary of relevant materials
• Compared to NASA’s MAPTIS materials database
• Helped to determine additional testing would be required for some samples
Outgassing Testing for SHERLOC on Mars 2020 Rover

- Requirements: Must pass ASTM E595 standards
  - <1.0% Total Mass Loss (TML)
  - <.1% Collected Volatile Condensable Materials (CVCM)

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<th>Pass</th>
<th>Fail</th>
<th>Unsure</th>
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<tr>
<td>Orthofabric</td>
<td>Bladder Material (&gt;1.0% TML)</td>
<td>Spectra</td>
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<tr>
<td>Polycarbonate</td>
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<td>nGimat Coated Orthofabric</td>
</tr>
<tr>
<td>Teflon</td>
<td></td>
<td>nGimat Coated Teflon</td>
</tr>
<tr>
<td>Vectran</td>
<td></td>
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<tr>
<td>Dacron</td>
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Outgassing Testing for SHERLOC on Mars 2020 Rover

• Requirements: Must pass ASTM E595 standards
  – <1.0% Total Mass Loss (TML)
  – <.1% Collected Volatile Condensable Materials (CVCM)

<table>
<thead>
<tr>
<th>Pass</th>
<th>Fail</th>
<th>Unsure</th>
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</thead>
<tbody>
<tr>
<td>Orthofabric</td>
<td>Bladder Material (&gt;1.0% TML)</td>
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<tr>
<td>Polycarbonate</td>
<td>Spectra (.4% CVCM)</td>
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<tr>
<td>Teflon</td>
<td>nGimat Coated Orthofabric (1.2% TML)</td>
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<td>Vectran</td>
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<tr>
<td>Dacron</td>
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<td></td>
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<tr>
<td>nGimat Coated Teflon</td>
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</tbody>
</table>
Tensile Testing of Radiated Space Suit Materials
Outgassing Testing for SHERLOC on Mars 2020 Rover
Z2 Support
LCVG Flush and Purge Console
Z2 Support: Pre Manned NBL Testing

- Assisted with preparing Corn Man
- Made a communication box mockup for the Corn Man test
Z2 Support: Pre-NBL Testing

• Assisted with preparing Z2 Processing Procedures
  – DIDB
  – MAG
• Assisted with preparing data scales
• Suit Fit Checks
Z2 Support: NBL Testing

• Weigh outs
  – Assisting as needed with keeping track of weight pack adjustments

• Contact Points
  – Recording contact points during testing
  – Developing standardized system/guidelines
  – Interpreting contact points results

• NBL Data
  – Organizing and combining data into one spreadsheet
Z2 NBL Support: Contact Points Analysis
Tensile Testing of Radiated Space Suit Materials

Outgassing Testing for SHERLOC on Mars 2020 Rover

Z2 Support

LCVG Flush and Purge Console
LCVG Modified Flush and Purge Console

• Objective:
  – Design an LCVG Flush and Purge Console

• Requirements:
  – Must be able to flush and purge the LCVG
  – Must be able to structurally test the LCVG
  – Must have access to both air and water
  – Must be as small as possible
  – ~$2000 budget

• Importance:
  – Ability to test at higher pressures
  – B34 location
LCVG Modified Flush and Purge Console

• Preparation
  – Became familiar with pressure system components
  – Pressure Systems Design Course
  – Reference previous LCVG Flush and Purge Console Design
LCVG Modified Flush and Purge Console

Breathing Air
@ MAWP 30 psig

Breathing Air
@ MAWP 200 psig

Water
@ MAWP 60 psig

Breathing Air Source
@ Maximum MAWP 200 psig
LCVG Modified Flush and Purge Console: Structure Test

Breathing Air @ MAWP 30 psig

Breathing Air @ MAWP 200 psig

Water @ MAWP 60 psig

Air

Water
LCVG Modified Flush and Purge Console: Purging LCVG

Breathing Air
- @ MAWP 30 psig
- @ MAWP 200 psig

Water
- @ MAWP 60 psig

Air
- Breathing Air Source @ maximum MAWP 200 psig

Notes:
1. System fluids are compressed air or water at room temperature (80 degree Fahrenheit).
2. System Max at 90.5 psig for the air side, and 60.5 psig for the water side.
3. System can handle 60.5 psig for air or water, whichever is lower.
4. 316L Stainless Steel 3/8" (3.410") or greater wall thickness unless otherwise noted.
5. All tubing is 316 Stainless Steel 3/8" (3.410") or greater wall thickness unless otherwise noted.
6. All valves are either hand or air actuated, unless otherwise noted.
7. System location 394 but can be connected to any existing air source with minimum MAWP of 60 psig.
<table>
<thead>
<tr>
<th>Definition</th>
<th>Manufacturer</th>
<th>Item</th>
<th>Manufacturer Part #</th>
<th>Manufacturer Part #</th>
<th>MAVP</th>
<th>Qualifications</th>
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<td>Pipe-PP-31</td>
<td>Anderson Bros Company</td>
<td>Shut Off Valve</td>
<td>3662T24</td>
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<td>Pipe-PP-35</td>
<td>Ansul Inc</td>
<td>Pressure Gauge (0-3000 psig)</td>
<td>9600685</td>
<td>020 poly 0.30</td>
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<td>PEAC-PP-35</td>
<td>Swagelok</td>
<td>Pressure Regulator (83)</td>
<td>KLFDBM411000 000</td>
<td>Half poly 0.30, Outlet 0.38 poly</td>
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<tr>
<td>RVLFP-04</td>
<td>Clock Set</td>
<td>Ball Valve (Air)</td>
<td>A-552795-6M</td>
<td>NA</td>
<td>7/8 Pipe Size, 300 Super Seal Seat at 150 psi</td>
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<tr>
<td>RVCFP-06</td>
<td>Clock Set</td>
<td>Check Valve</td>
<td>472N529</td>
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<td>Clock Set</td>
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<td>40944K2</td>
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<td>Check Valve</td>
<td>96A42006</td>
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<td>PD-LFP-10</td>
<td>Ansul Inc</td>
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<td>4986562</td>
<td>020 poly</td>
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<td>NV-LFP-11</td>
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<td>Needle Valve</td>
<td>44445K10</td>
<td>3000 poly @ 400F</td>
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<tr>
<td>TFP-LFP-12</td>
<td>Dan Mang Corp</td>
<td>Tefl In</td>
<td>444S14T1</td>
<td>NA</td>
<td>Polyethylene plastic, max temperature 180F, system capacity</td>
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<td>GQCI-LFP-14</td>
<td>Tripp-Lite</td>
<td>Surge Protector with GQCI and Switch</td>
<td>TLW600TG</td>
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<td>NP-LFP-16</td>
<td>General Electric</td>
<td>Filter System</td>
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<td>RP-LFP-17</td>
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<td>Filter</td>
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<td>46624K61</td>
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<td>TG-LFP-24</td>
<td>Tripp-Lite</td>
<td>Surge Protector with GQCI and Switch</td>
<td>TLW600TG</td>
<td>1500K49</td>
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<td>Tripp-Lite</td>
<td>Surge Protector with GQCI and Switch</td>
<td>TLW600TG</td>
<td>1500K49</td>
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<td>Tripp-Lite</td>
<td>Surge Protector with GQCI and Switch</td>
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<td>1500K49</td>
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<tr>
<td>C-LFP-27</td>
<td>Orange</td>
<td>Backflow Male Connector</td>
<td>204U91</td>
<td>NA</td>
<td>150 poly</td>
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<td>C-LFP-28</td>
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<td>Backflow Male Connector</td>
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<td>NA</td>
<td>150 poly</td>
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<td>C-LFP-29</td>
<td>Orange</td>
<td>Backflow Male Connector</td>
<td>204U91</td>
<td>NA</td>
<td>150 poly</td>
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</tr>
</tbody>
</table>
LCVG Modified Flush and Purge Console: RV Calculation

**Pressure Regulator**

- \[ Q = C_v \times \left( \frac{816 \times P_1}{\sqrt{S.G. \times T}} \right) \]
- \[ Q = 0.02 \times \left( \frac{816 \times 214.7}{\sqrt{1 \times 530}} \right) \]
- \[ Q = 153 \text{ SCFH} = 2.5 \text{ SCFM} \]
LCVG Modified Flush and Purge Console: Approval Process

1876 Form
366S Form
366C Form
Hazard Analysis
LCVG Modified Flush and Purge Console: Status

- ✔ Preliminary Research/Preparation
- ✔ Design Sketches
- ✔ Technical Drawing
- ✔ Bill of Materials/ Determining Components (Calculations)
- ✔ Required Forms (1876, 366S, 366C)
- ✔ Hazard Analysis
- ✔ Pressure Systems Approval
- - Order Components and Assemble
- - Test/Inspect/Final Approval
Lessons Learned

• Data can be confusing at times
  – Example: Material appeared to be stronger after radiation

• A lot goes into the formal design process
  – Design review, forms, Hazard Analysis, inspection, etc.

• Understanding specifications
  – AN vs NPT
  – Tube vs Pipe

• Learning about pressure system components
  – In addition to pressure ratings, need to consider size and flow rates
Skills Acquired

- Tensile Testing
  - Prepare materials and setting up the tensile tests
  - Collect and interpret (messy) data
- Outgassing Testing
  - Understand TML and CVCM
  - Collaboration with other NASA centers
- Z2 Support
  - Hands on building mockups of components
  - Analyze data
  - Work with others; understanding what both parties need in order to make a run successful
- LCVG Flush and Purge Console
  - Both formal design and design review process
  - How to determine which components to use; flow calculations, pressure ratings, size, etc.
  - Hazard Analysis
  - How to make design tradeoffs
## Future Plans

<table>
<thead>
<tr>
<th>Year</th>
<th>Spring</th>
<th>Summer</th>
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<tr>
<td>2017</td>
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<td>CM4 Co-op</td>
<td>UMD</td>
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<tr>
<td>2018</td>
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<td>Class and Graduate with B.S. in Aerospace Engineering</td>
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<td>Grad co-op/Starting Ph.D.</td>
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Acknowledgements

• Kris Larson
• Amy Ross
• Richard Rhodes
• Raul Blanco
• Teresa Shurtz
• Ian Meginnis
• Ben Peters
• Steve Anderson
• John Harris
• Pete Meeh

• Kevin Groneman
• Nate Smith
• John Hollis
• Joe Settles
• April Smith
• Jonathan Abary
• Amber Tucker
• Everyone in EC5
• All the co-ops and interns in EC5 (Chad, Kelly, Sarosh)
Questions?