

# Coal Too Valuable To Burn ...

Presented to AMCC

By Dr. Tulinda Larsen, Executive Director UAMMI

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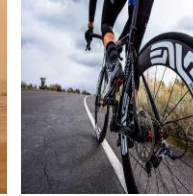


# Utah Advanced Materials and Manufacturing Initiative

## *The Future of Manufacturing*

**MISSION:** Expansion of Utah's Advanced Materials & Advanced Manufacturing Industry

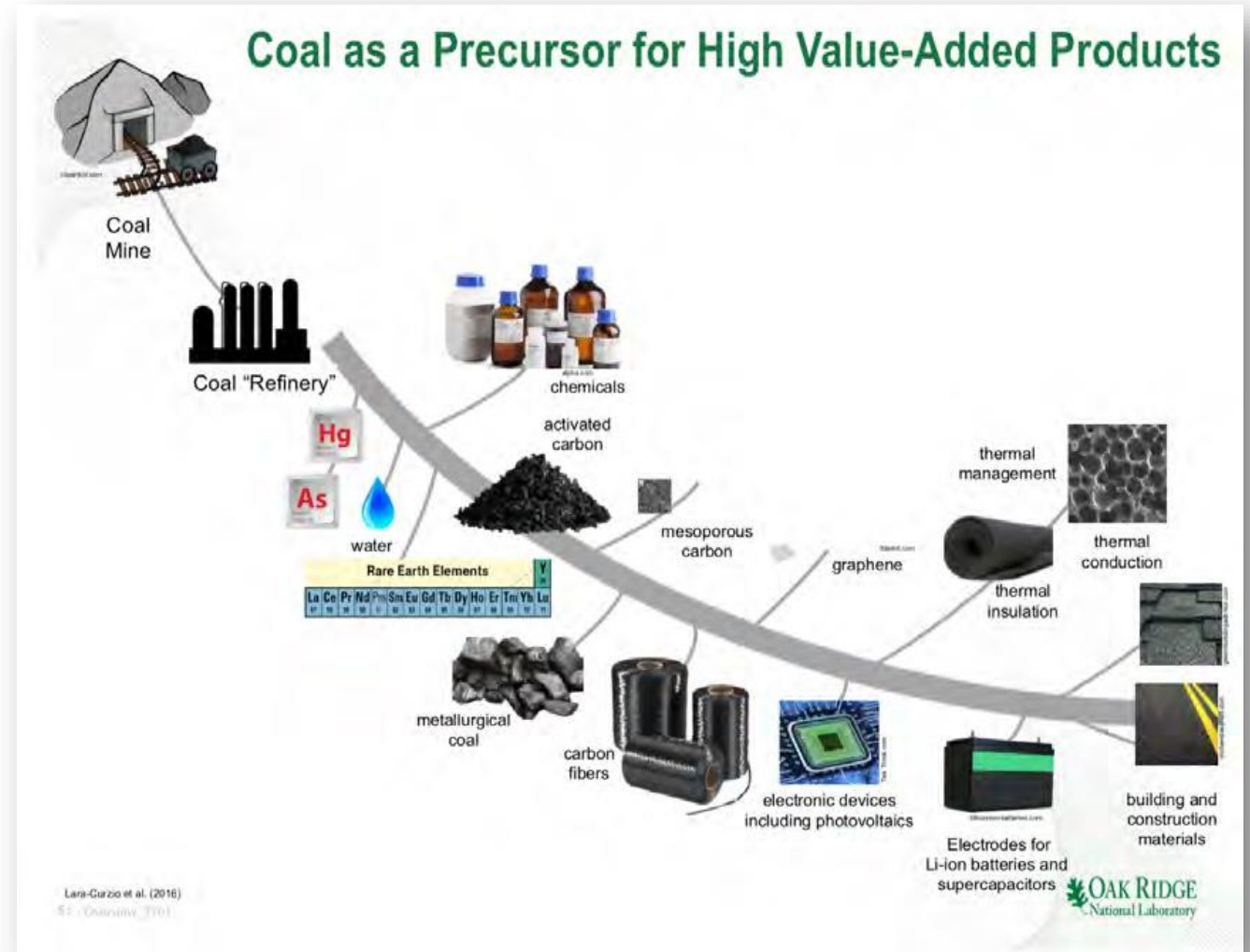
- Materials: Carbon Fiber, Advanced Alloys, Ceramics, Polymers
- Manufacturing: High precision manufacturing using robotics and 3D printing
- Markets: Defense, Commercial Aerospace, Medical, Outdoor Rec
- Impact: 167 companies statewide with 15,000 workers, >\$600M impact



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# Let's Talk About Coal – Too Valuable to Burn!!

- Uses of coal in high value-added products, including carbon fiber, graphene, electronic devices, including photovoltaics, electrodes for Li-ion batteries and supercapacitors, and a wide range of building materials
- Conceptually think of refining coal like refining oil



# Utah Coal to Fiber Grant

- Grant from Economic Development Admin EDA – U.S. Dept of Commerce – 2016

*Project completed 2020*

- Objective: Use Utah coal for low-cost carbon fiber & job creation in rural Utah
- Led by University of Utah
  - University of Kentucky
  - UAMMI
- Successfully made pitch and viable fiber



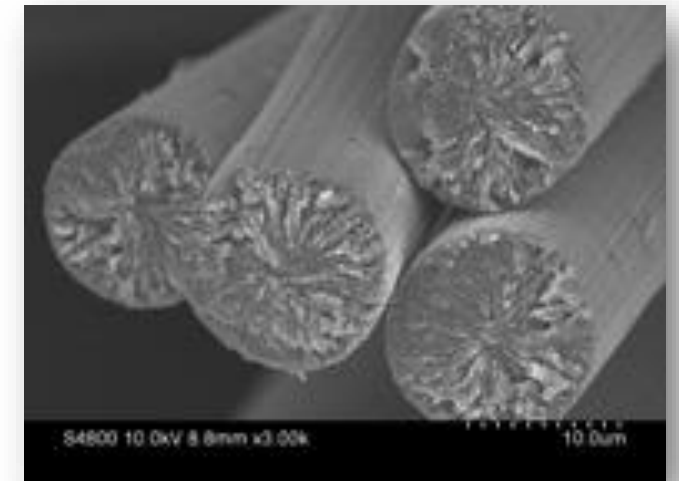
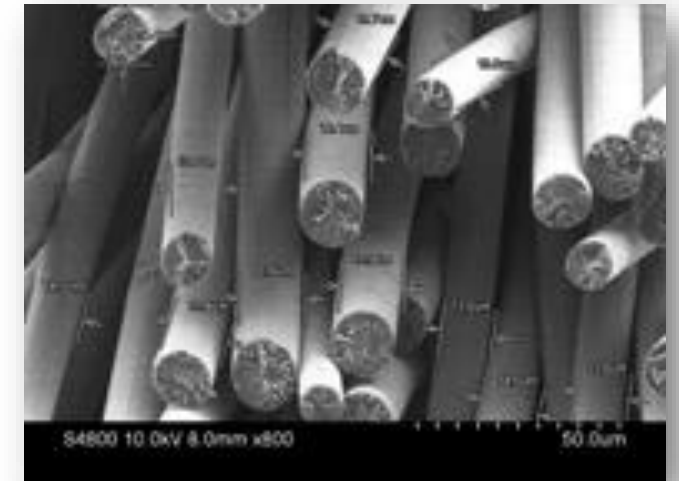
Jay Williams, U.S. Assistant Secretary of Commerce for Economic Development, and Dr. Eric Eddings, University of Utah



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# Success in the Lab

- Top picture shows the well- formed graphitized fibers
  - Smooth, straight
  - Look the same as PAN-based fiber
- Bottom picture shows crystalline structure of graphitized fibers
- Successfully made pitch and viable fiber in the lab in gram quantities



# Fiber Test Properties Are Stiff, But Weak

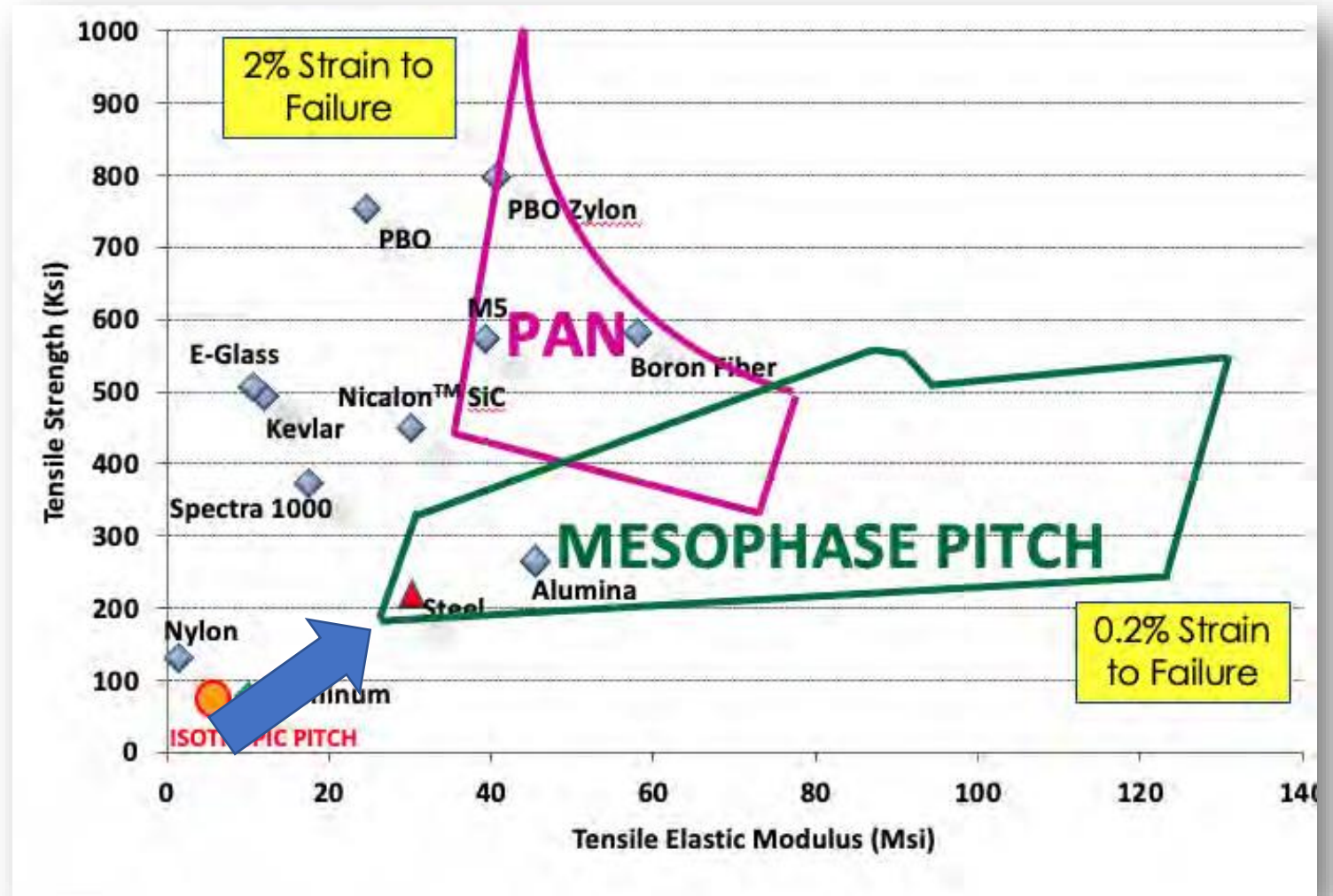
- Modulus is super high at 630.66 GPa indicating high stiffness
- *However, not strong as indicated by the stress at break point and strain at break is very low, meaning material is brittle*
- Aerospace requires both strength and stiffness
- Automotive industry requires stiffness, not strength

Gauge Length (mm)	Diameter (mm)	standard deviation (mm)	Stress At Break (MPa)	standard deviation (MPa)	Modulus (GPa)	standard deviation (GPa)	Strain at Break (%)	standard deviation (%)	Strain Energy Density (MJ/m3)	standard deviation (MJ/m3)	N
AVE	14.36	2.03	970.89	433.07	630.66	154.49	0.15%	0.07%	0.87	0.66	64



# Mitigation Plan

- Broaden the processing window in temperature and time, which will make it easier to “spin” the fibers, which means extruding the fibers
- Mesophase pitch fibers are very, but not strong
- Mitigation requires upgrading the isotropic pitch to mesophase



# Research Continues with DOE Funding & State Funding



*U.S. Department of Energy Award June 1, 2020 – May 31, 2022*

- **University of Utah**

*Department of Chemical Engineering Scientific Computing and Imaging Institute*

- **University of Wyoming**

*School of Energy Resources*

- **Marshall University**

*Center for Environmental, Geotechnical and Applied Science*

*Center for Business and Economic*



*State of Utah appropriated additional funds for FY22*





# New Project Objectives

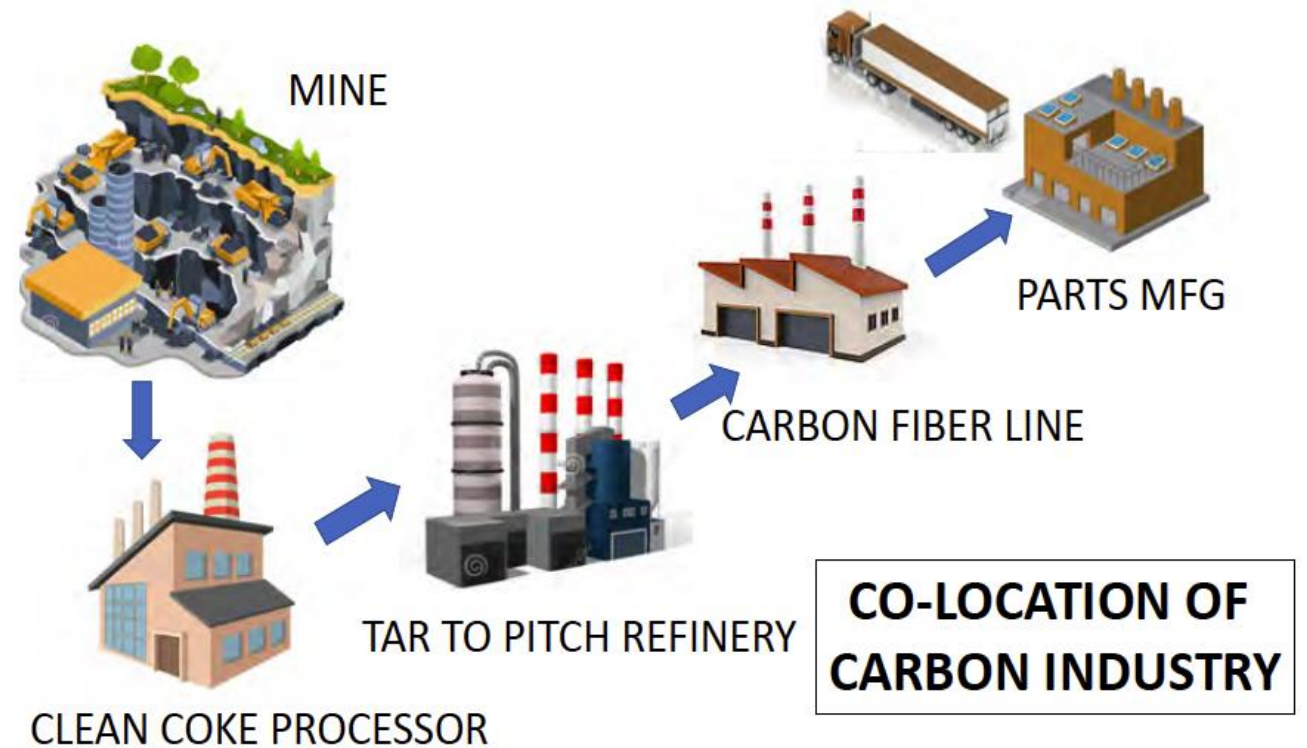


- *Produce carbon fiber derived from coal tar pitch*
  - Will include coals from multiple coal-producing regions
- *Produce high-value Silicon Carbide (b-SiC) byproduct*
  - Using carbon residue material (e.g., char) from carbon fiber production
- *Develop extensive database and tools for data analysis and economic modeling, accessed by a web-based portal*
  - *Relate coal properties and process conditions to final quality of products*
  - *Assess the economic viability of coals from different regions for producing specific high-value products*



# UAMMI Envisions Revitalization of Coal Industry

- Workforce requirements will be from the mine to the manufacturing facility
- All types of workers will be needed
- The skills for these jobs include understandings of materials flow, impacts of temperature, safety for chemical



A photograph of an industrial facility, likely a coal refinery, with complex piping, scaffolding, and yellow safety railings. The scene is dimly lit, with some bright spots from overhead lights. A large white circular overlay is positioned on the left side of the image, containing text.

# Private Company Building Production Plant

- Developed coal refining technology to produce:
  - Solid carbon for building materials
  - Pitch for carbon fiber
  - Hydrogen
  - Fertilizer
- Currently in project funding stage
  - Working with Bayer Fertilizer, IACMI, and venture fund (Monta Vista Capital)

# Utah Submitted Proposal to DoE on CORE-CM

- DOE Carbon Ore, Rare Earth and Critical Minerals (CORE-CM)
- DoE Initiative for U.S. Basins - Carbon Innovation Designation
- Scale up to commercial



# Utah CORE-CM Consortium

- University of Utah
- UAMMI
- IACMI
- Colorado School of Mines
- Los Alamos National Lab
- Wolverine Fuels
- Utah State University
- Energy and Geoscience Institute
- Utah Geological Survey
- Colorado Geological Survey
- JWP Consulting LLC
- Arcadia Minerals Inc.
- Black Mountain Resources
- Carbon County
- Ekomatter, LLC./Combustion Resources Partners
- Emery County
- Energy Fuels
- FTX
- K. Marc LeVier and Associates, LLC
- Monsanto
- North American Coal Corp
- RAMACO
- Red Leaf Resources Inc.
- Seven County Infrastructure Coalition
- The Graphene Council
- University of Alaska
- University of North Dakota
- UT Gov. Off. Economic Development
- UT Gov. Off. Energy Development
- Vermeer



A hand wearing a white glove holds a large, dark, layered piece of coal in the foreground. The background is a blurred coal mine with heavy machinery and a large pit.

# Policy Challenges

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- Educating policy makers on the value of extracting coal for non-fuel uses
- Innovating clean processes
- Continuing investment in the technology to refine coal

Thank You!  
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