High-value Products from Western Coals

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Western States Coal Strategies Forum

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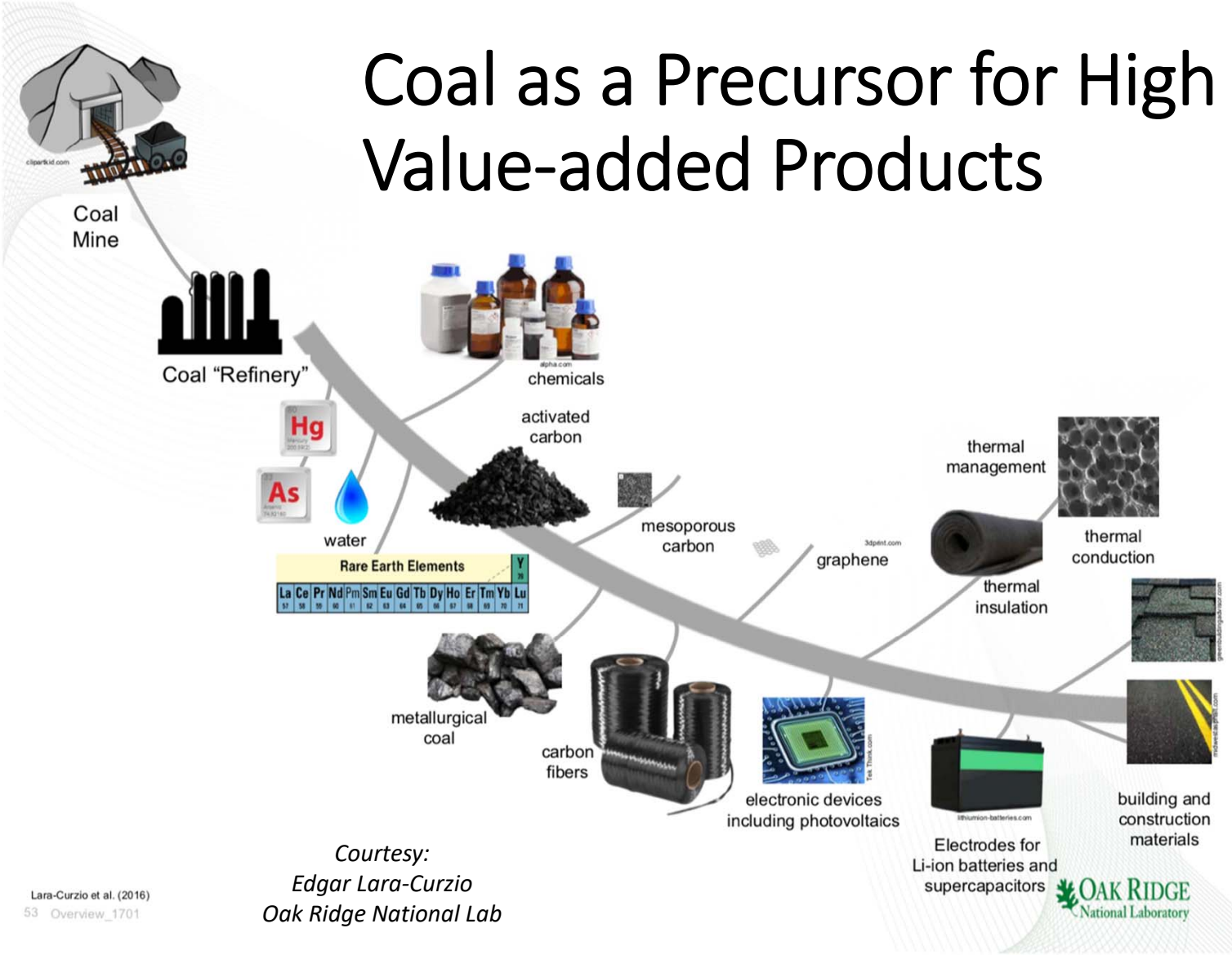
Coal as a Precursor for High Value-added Products



Courtesy:
Edgar Lara-Curzio
Oak Ridge National Lab

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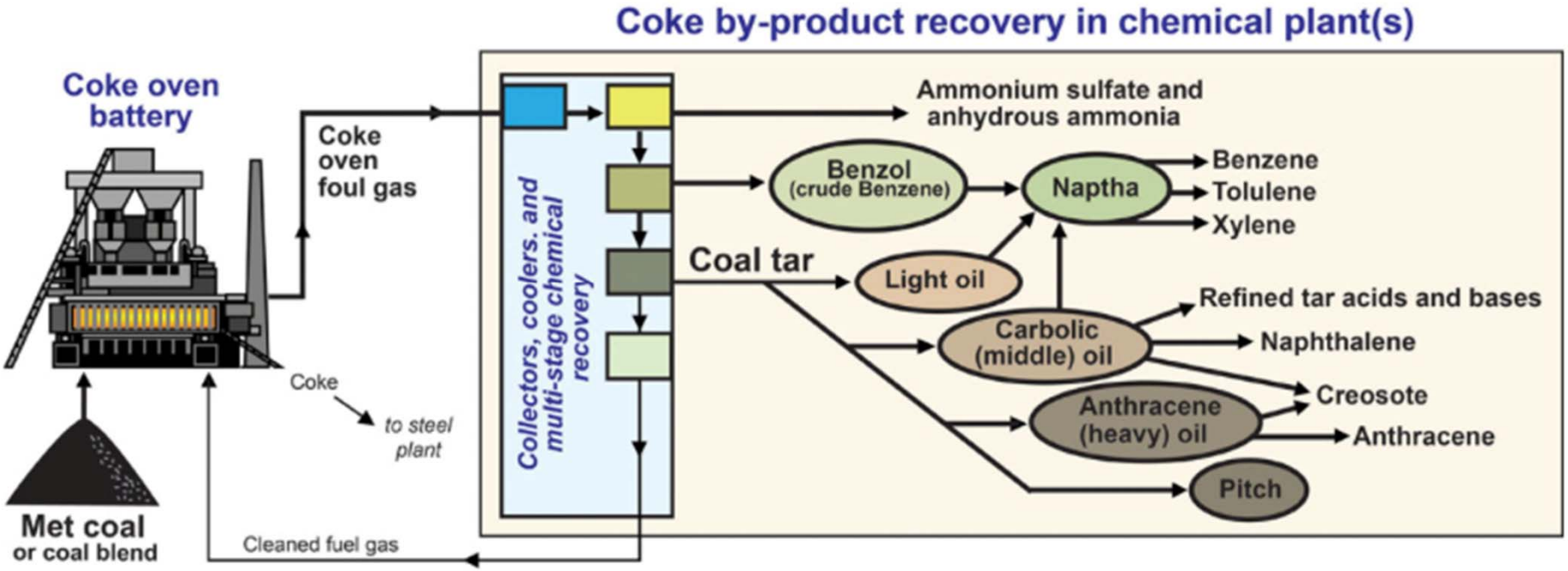
Coal Processing in Coke Ovens: Chemicals Production



The technology is well-developed for metallurgical-grade coals, primarily for production of chemicals

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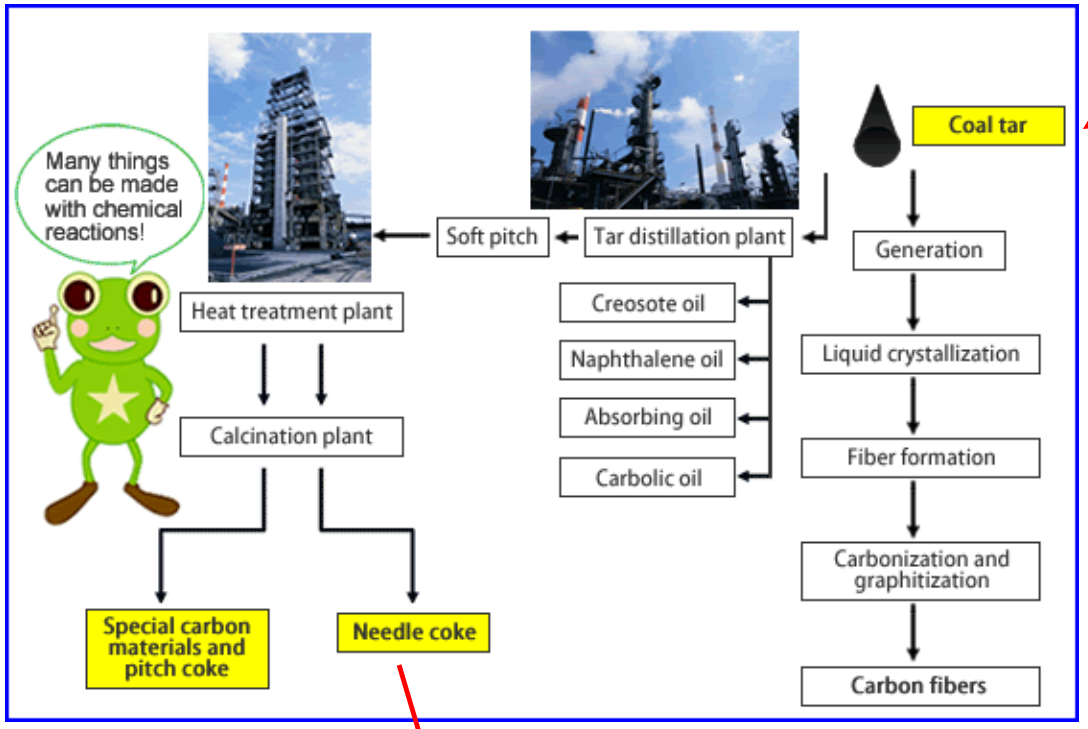
Commercial Production of High-value Coal-derived Products (Mitsubishi Chemical)

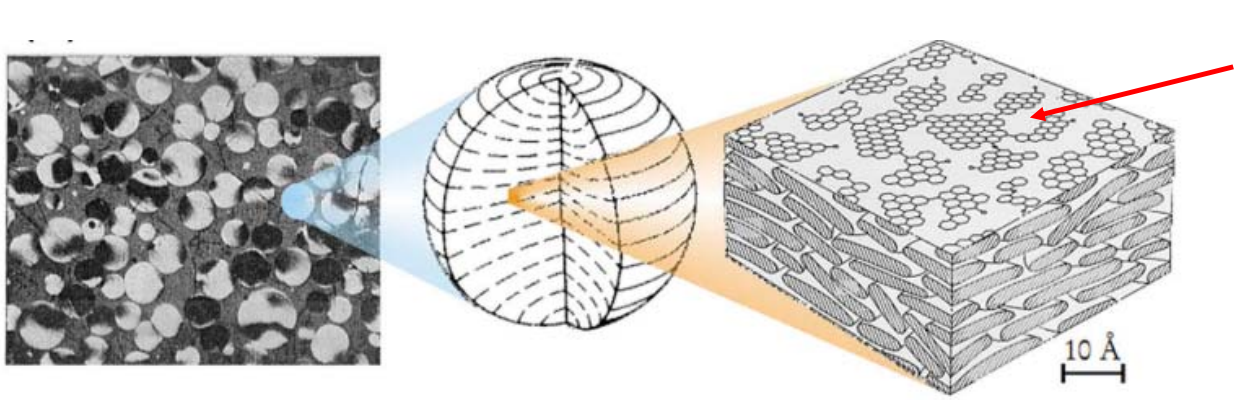


What about coals that are <u>not</u> traditional metallurgical grade coals?

https://www.m-chemical.co.jp/en/products/departments/mcc/coke/product/1201080_7940.html

Objective

- Utilize non-coking coals for purposes other than energy generation
  - *Create high-quality mesophase pitch for carbon fiber or needle coke production*

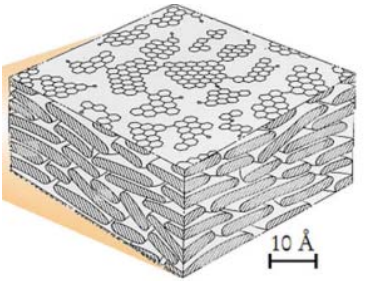


Need large PAH's like these

F. Guo, R. Hurt, "Supramolecular Synthesis of Graphenic Mesogenic Materials" *Macromolecular Chemistry and Physics,* 2012, 1164-1174.

Utilization of Western Coals

- **Challenge:**
  - Pyrolysis tar products from these coals tend to have excessive aliphatic/oxygen groups that inhibit mesophase formation/coalescence
  - These functional groups lead to cross-linking that inhibits stacking
- **Approach:**
  - Design appropriate reaction sequences for each coal type to allow production of mesophase pitch (temperatures, residence times, oxidizing vs. inert)
    - *for carbon fiber and needle coke production*
  - Requires appropriate conditions for liquid crystal (LC) formation and coalescence
    - *Narrow T range – formation rate vs. premature coking*
    - *Appropriate MW range for "solvent" hydrocarbon for LC's*
- Have demonstrated that a coal (Utah Sufco), not initially good for making mesophase/needle coke, has performance improved significantly by appropriate reaction conditions



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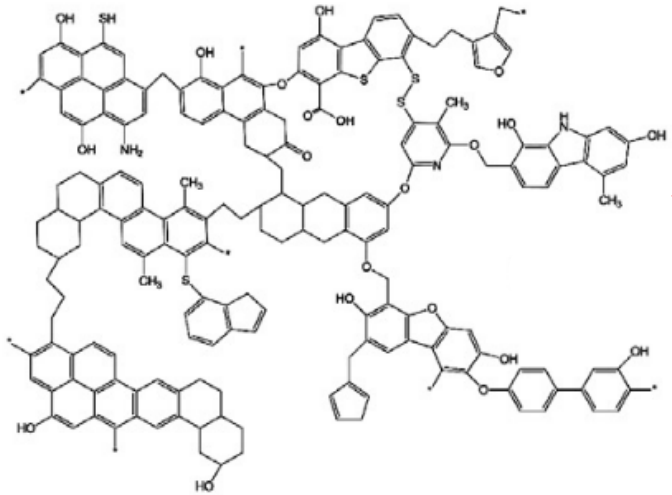
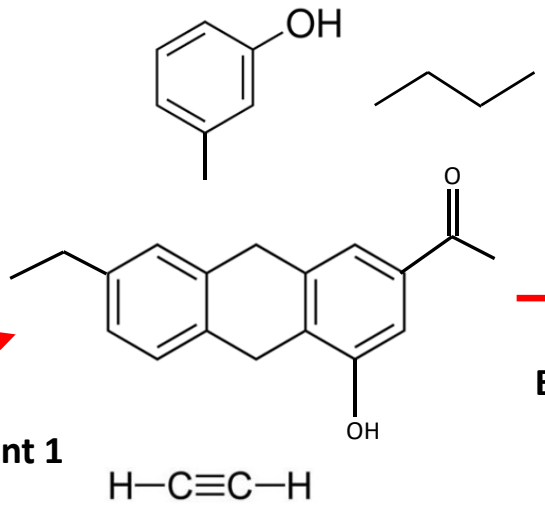
Example: Coal Pyrolysis & Secondary Reactions

Proposed Bituminous Coal Structure*



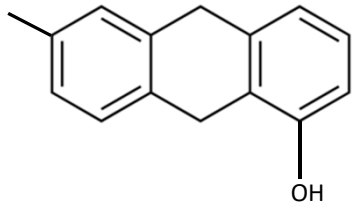
T_1, t_1

Gas Environment 1



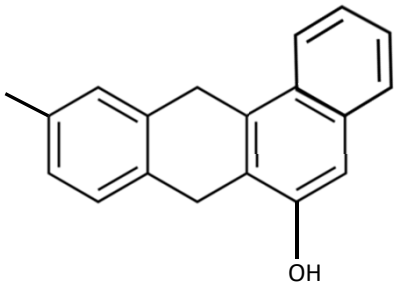
T_2, t_2

Gas Environment 2



T_3, t_3

Gas Environment 3



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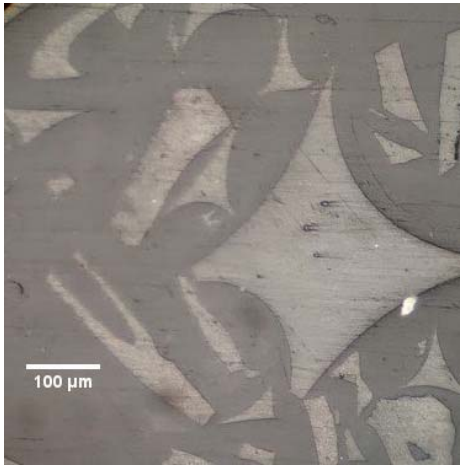
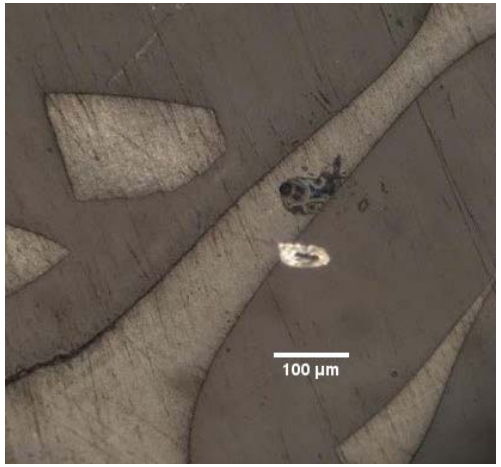
*Wiser WH. Conversion of bituminous coals to liquids and gases. In: Petrakis L, Fraissard J, editors. Magnetic resonance. Introduction, advanced topics and applications to fossil energy (NATO ASI Series C), vol. 124. D. Reidel Publishing Company; 1984. p. 325.

Scanning Electron Microscope (SEM) Results for Mesophase Formation

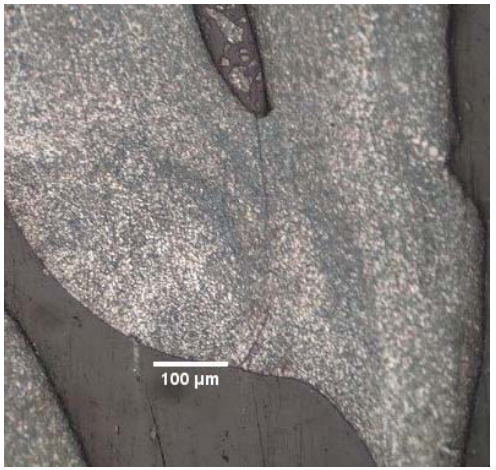
U-MCTP-0



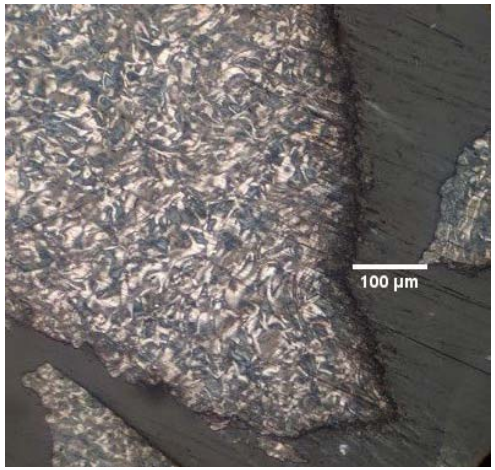
U-MCTP-1



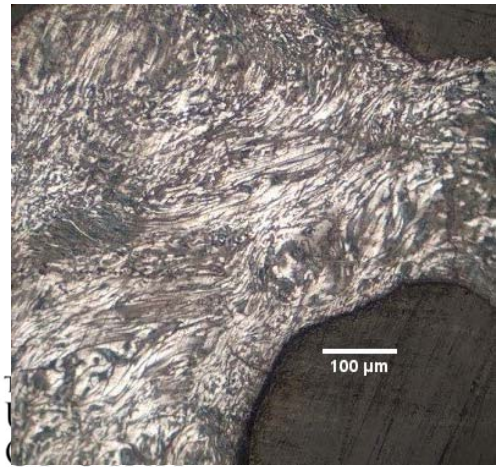
U-MCTP-1.4



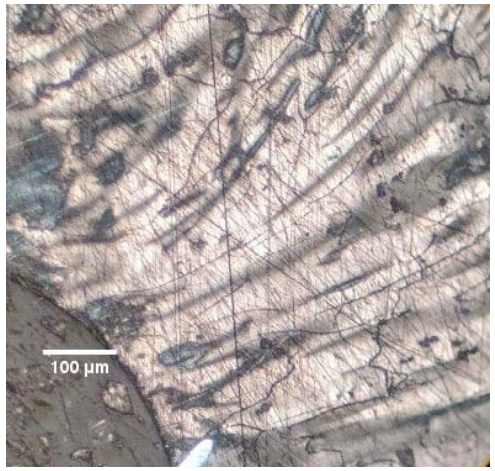
U-MCTP-1.8



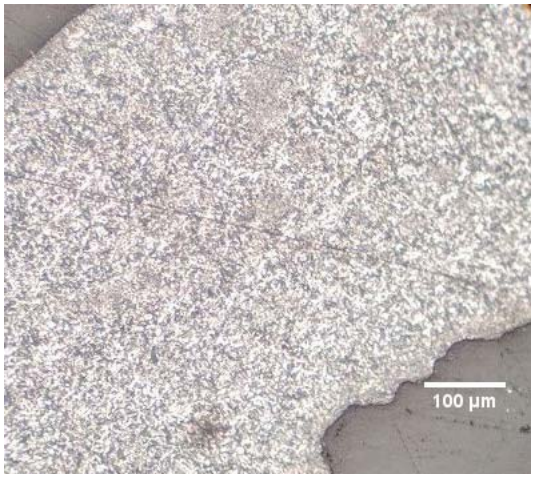
U-MCTP-18



MCTP-A



MCTP-B



Concluding Comments on Coal Products Efforts

- The University of Utah is working on:
  - Production of mesophase pitch from coal for carbon fiber and needle coke production (anodes) *(Eddings, Mohanty, Weisenberger-UofKY, UAMMI)*
  - Development of sodium-ion battery using “hard carbon” materials derived from coal *(Warren, Eddings)*
  - Development of web-accessible database to link coal properties with required processing conditions for different high-value products *(Pascucci, Johnson)*
  - Production of H_2 and CO_2 from coal using photo-catalytic electro-oxidation via black titania nanotubes. *(Mohanty, Eddings)*

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Thank you!

Questions?

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