What does this group do?

- **What are Coal Combustion By-products:** minerals that remain after coal is burned to generate electricity:
  - Fly ash
  - Bottom ash
  - FGD products
  - Boiler slag

- The ECT group *develops products and processes that manufacture construction materials from CCB’s* such as cements, grouts, wallboard, masonry blocks, fillers, etc.

- The ECT group *investigates all aspects of coal combustion by-product utilization.* As such, it generates information for the transfer of new ideas to benefit the innovative utilization, handling, storage and disposal of CCBs

[Image of minerals and diagram showing emissions and their utilization in construction materials]
What does this group do?

- **Coal combustion and coal gasification by-products processing**
  - Develop beneficiation technologies to produce high-quality, consistent products from ash/slag

- **Concrete and mortar**
  - Develop an intensive research program focused on CCB chemistry and end-use quality considerations
What does this group do?

• **Project: Tekcrete Fast**

Unique technology that allows a fiber-reinforced, high-strength, ultra-rapid setting concrete to be applied for almost immediate stabilization of unstable geological strat for mining purposes, and damaged infrastructures.

What does this group do?

• Project: Tekcrete Fast

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What does this group do?

• **Project: Tekcrete Fast**
  Unique technology that allows a fiber-reinforced, high-strength, ultra-rapid setting concrete to be applied for almost immediate stabilization of unstable geological strat for mining purposes, and damaged infrastructures.


• **Collaboration with the College of Design**
  Creation of viable products using geopolymer concrete produced entirely from coal ash
What does this group do?

- **Dry FGD Material Research (Longjin project)**
  This project involves both fundamental studies of the dry flue gas desulfurization (FGD) material, and its interaction with OPC.

- **Spray Drier Absorber Materials (EPRI project)**
  Determine their potential use as replacement for Portland cement in concrete

- **Materials Testing Support for Industrial By-products**
  ECT group has the capability to contract out characterization and testing services, as applied to CCBs in cement, among other types of materials.
Ongoing project: Cement as a Novel Electric Source for Energy-Harvesting Materials

- **Ettringite**:  
  - provides the primary strength in CSA cements (low-energy low CO₂ cements = alternatives to OPC), and early strength in OPC

- **Piezoelectric materials**:  
  - have the ability to interchange mechanical strain energy into electrical charge  
  - commonly used in dynamic applications involving vibration suppression, mechanical impact and sensing, **but** not so much for energy harvesting (by mechanical processing)

**Goal:**  
To quantitatively and unambiguously **verify the piezoelectric effect** of ettringite. This discovery will lead to numerous applications in the piezoelectric and energy harvesting industry.
Ongoing project: Development of Low-CO$_2$, Low-Energy Hybrid Cements

**Parameters:**
- Choice of raw materials
- Composition
- Firing temperature
- Dwell time

**Ordinary Portland cement (OPC):**
- Alite
- Belite
- Tricalcium Aluminate
- Ferrite

**Calcium Sulfoaluminate cement (CSA):**
- Calcium Sulfoaluminate
- Belite
- Ferrite

**Hybrid Cement:**
- Calcium Sulfoaluminate
- Alite

**Goal:**
Optimize production of hybrid cement from exclusively by-products
What skills and expertise can you acquire?

- **Chemical Engineering**
  - Processing and analysis of raw materials
  - Chemical testing of cement
  - Design and safety of cement production

- **Materials Engineering**
  - Material characterization (XRF, LOI, XRD, SEM, PSD, Microscope,…)
  - Synthesis and optimization of clinker / cement / concrete
  - Mechanical testing
  - Hydration process

- **Mechanical Engineering**
  - Mechanical testing
  - Equipment design
  - Optimization of process / testing / methods

- **Civil Engineering**
  - Material characterization (XRF, LOI, XRD, SEM, PSD, Microscope,…)
  - Synthesis and optimization of clinker / cement / concrete
  - Mechanical testing
• The ECT group has collaborations all over the world:
  • Australia, China, France, Scotland, Turkey,…

• Where does the ECT group get funding from?
  • National Institute for Hometown Security (Department of Homeland Security)
  • Electric Power Research Institute (EPRI)
  • Companies (Minova, Ecocem)
  • Utilities (WE Energies, Duke, AEP)
  • National Science Foundation (NSF)
  • Longjin (China)

• Where does the ECT group publish?
  • Cement and Concrete Research
  • American Concrete Institute (ACI)
  • Shotcrete Magazine
  • Journal of Sustainable Cement-Based Materials
  • Coal Combustion and Gasification Products

• Where does the ECT group present its results?
  • World of Coal Ash (WOCA)
  • American Concrete Institute
  • International Concrete Conferences in Dundee
  • Asian Coal Ash Association (ACAA) in China

• Where do students that work in the ECT group go afterwards?
  • Academia (ESIREM, Middle East Technical University, Nanjing Tech University)
  • Industries / Utilities (Palmer Engineering, Vantage Engineering, Boral, C&I Engineering)