CO_2 Mineralization Using Porous Carbon and Industrial Wastes To Make Multifunctional Concrete

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Background

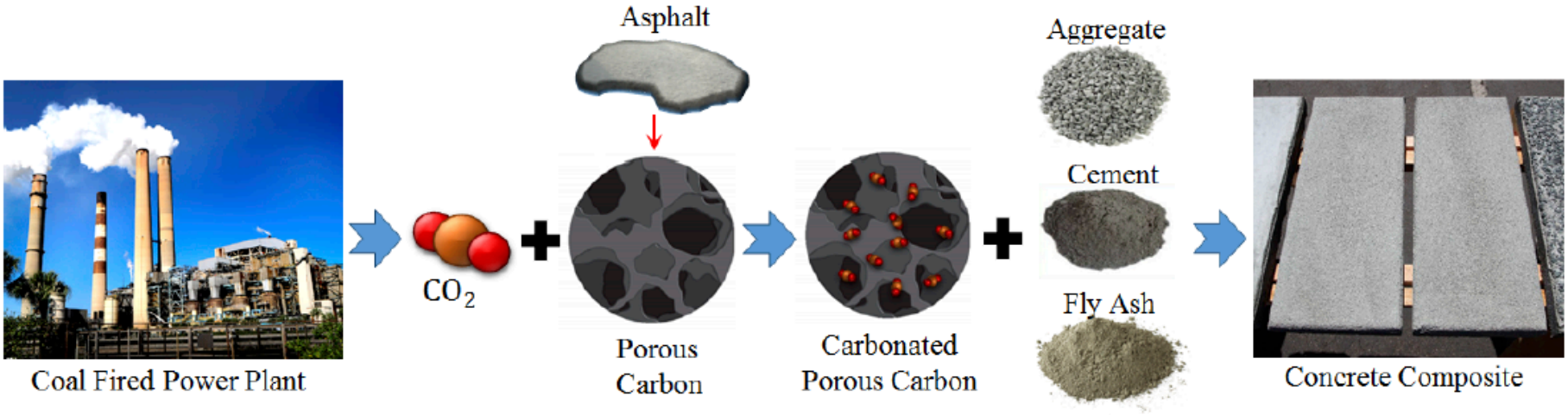
CO_2 mineralization using Ca- and Mg-based materials such as olivine, serpentine, and wollastonite are impractical due to low kinetics and high cost

Two Key Challenges:

1) Increasing the value of the final chemicals or products,
2) Enhancing the reaction kinetics and efficiency of the process

Overall Project Goal

In-situ two-step CO_2 mineralization in confined nanopores, followed by utilization in concrete to provide multifunctionality



Porous carbon:

1) It provides low activation pathways for mineral carbonation process, enhancing the kinetics of the process by adsorbing CO_2 as a gas.
2) The availability of a wide variety of carbon sources (e.g., asphalt, biomass, etc.)

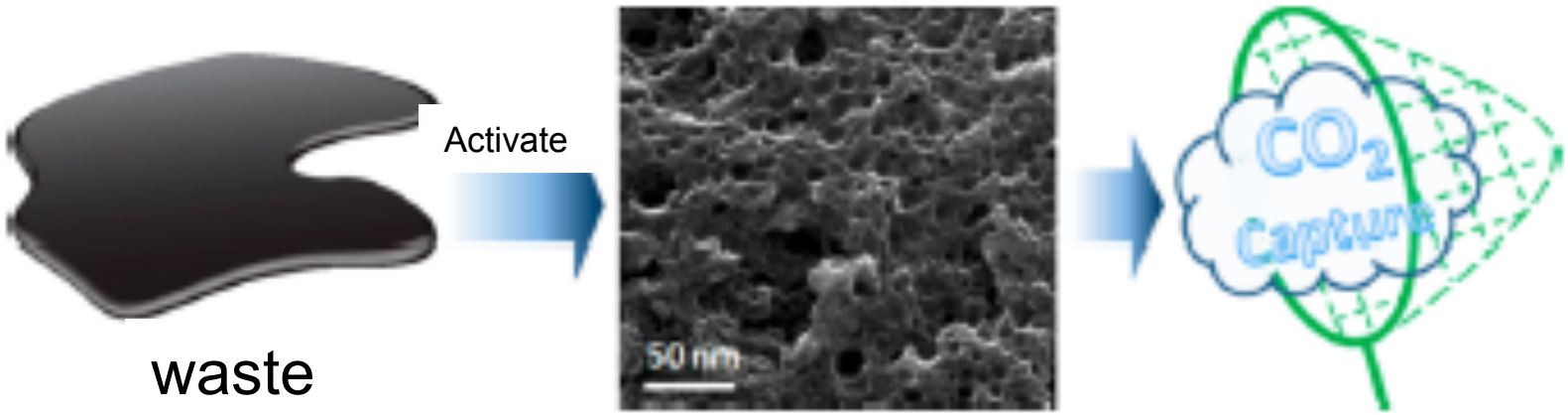
Specific Objectives

- Objective 1: to develop activated carbon to offer the best solution to CO_2 mineralization using industrial wastes.
- Objective 2: to create a facile protocol to prepare concrete products comprising carbonated mineral/carbon materials and testing them in accordance with the ASTM/AASHTO standards
- Objective 3: to perform life-cycle/risk analysis, scale-up, pilot test and integration with current methods and equipment used for concrete mixing with minimal modification

How it works

Our process nearly doubles the surface area of the porous carbons and substantially increases the CO_2 absorption factor, a precursor for faster mineralization and/chemisorption.

The pretreatment step is essential to form higher boiling species



waste

Key Advantages

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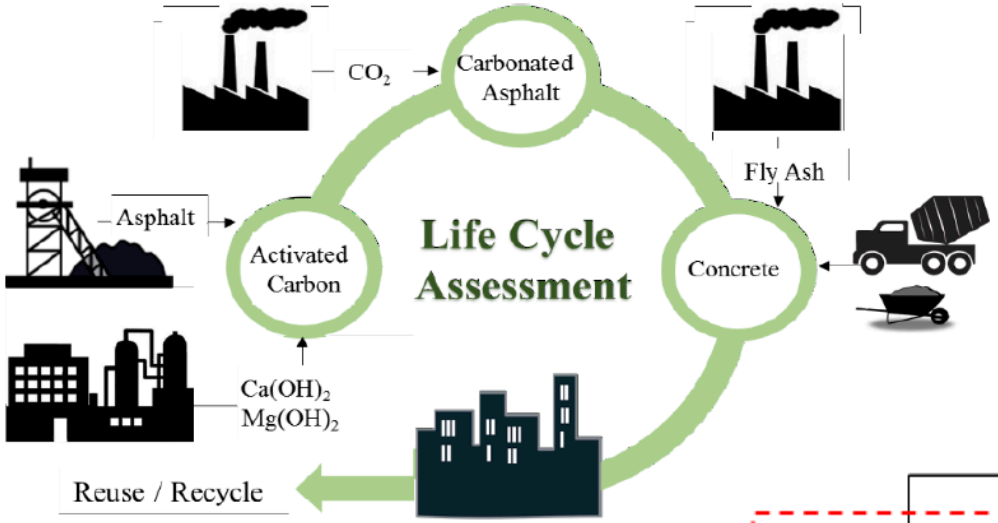
1) Mechanical Reinforcement in Concrete (to do more with less)

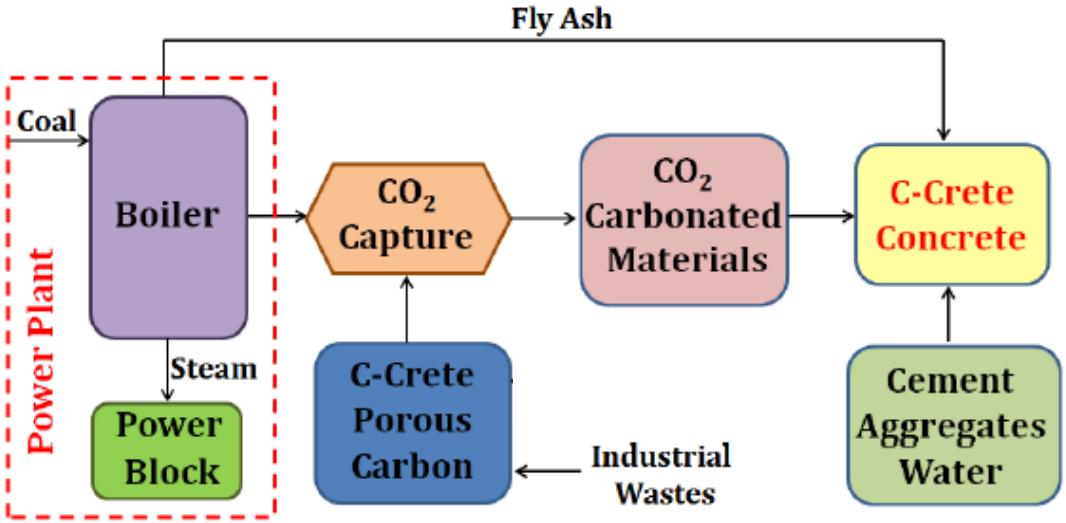
2) High electrical, thermal and magnetic properties (electromagnetic shielding, roadway deicing, etc).

3) Besides capturing CO_2, the technology can employ several other by-products of coal-fired power plants (flyash, etc).

4) It can be integrated to power plants via bubbling the CO_2 gas to solutions containing our treated porous carbon and industrial wastes → both cast in place and precast concrete

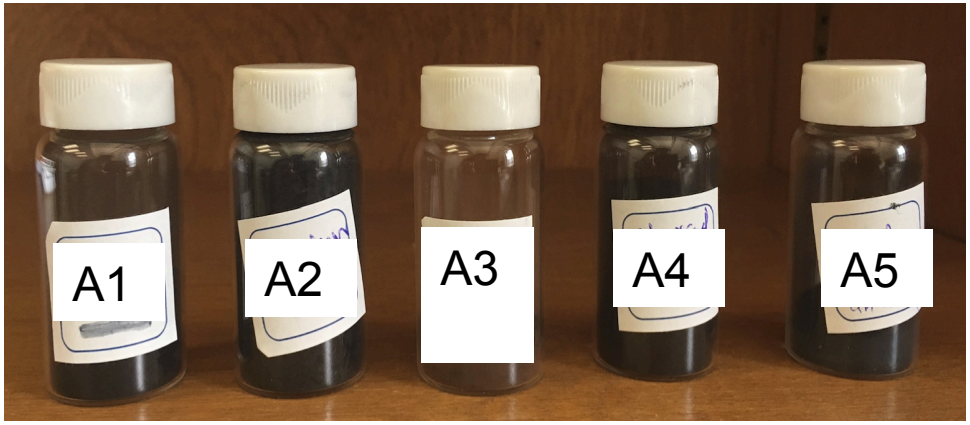
LCA and Implementation

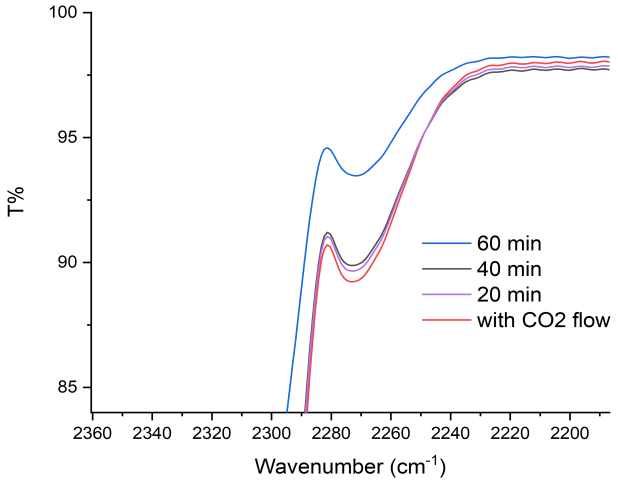


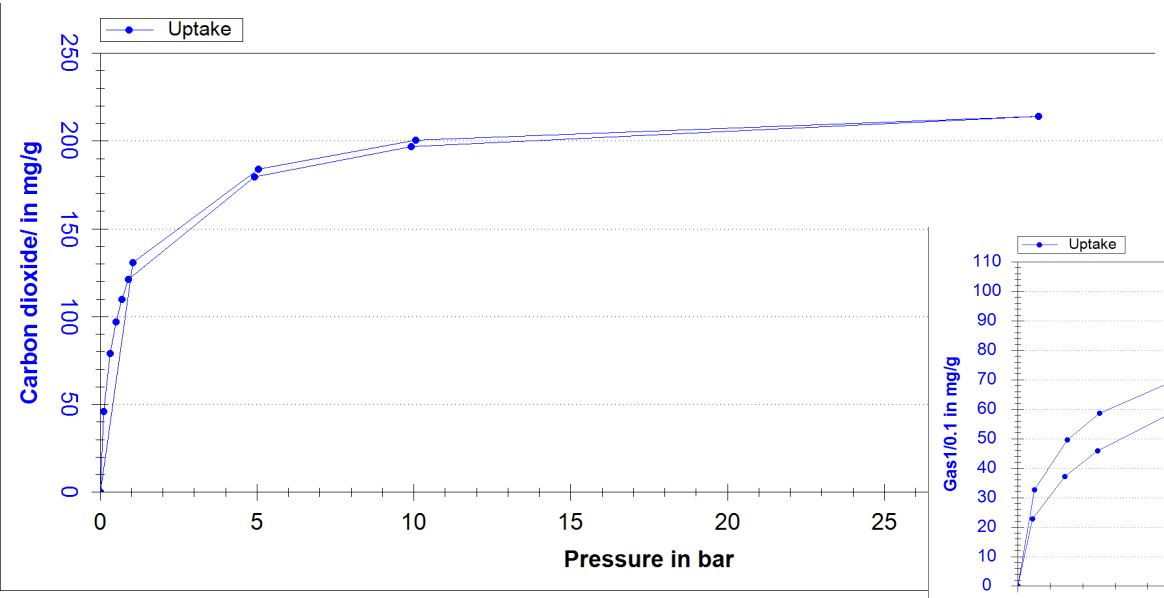


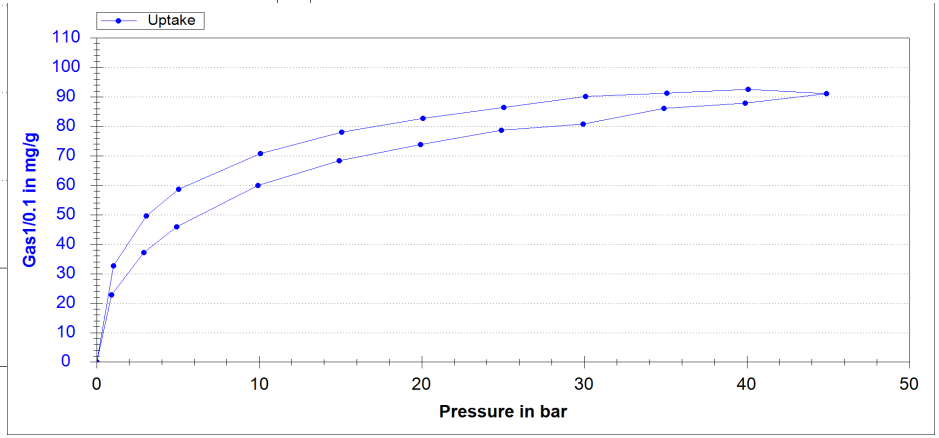
Shahsavari et al, Journal of American Ceramics Society, 2018

Preliminary Results









Preliminary Results

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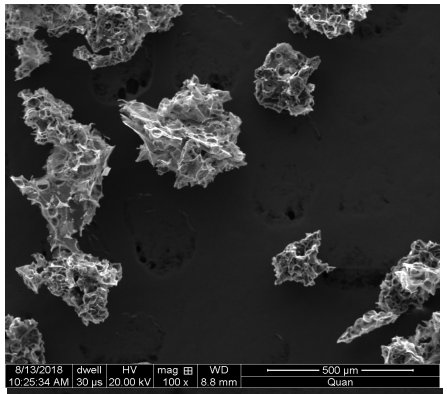
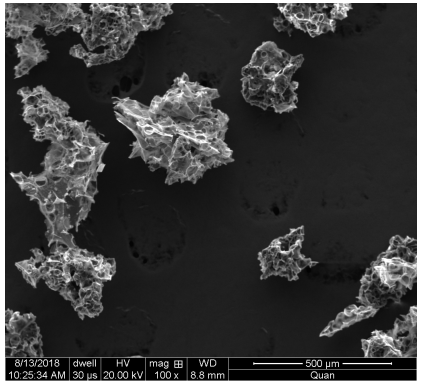
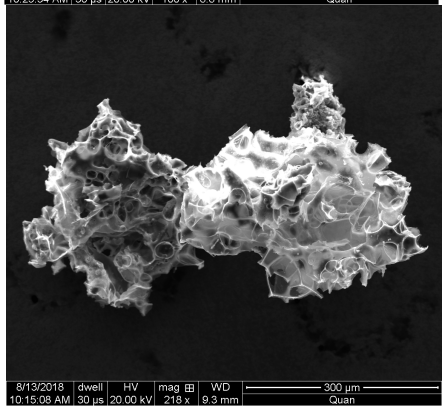
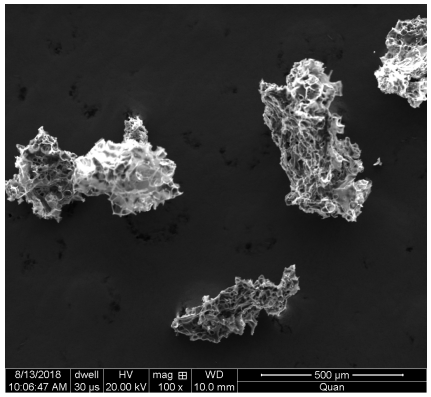
Before

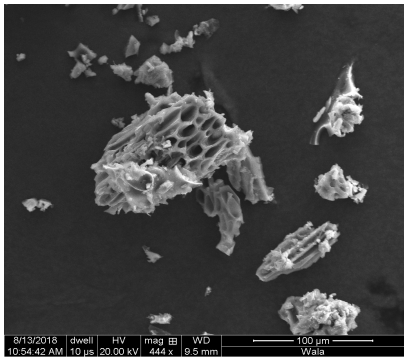


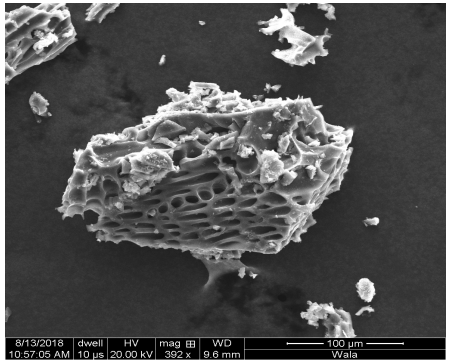


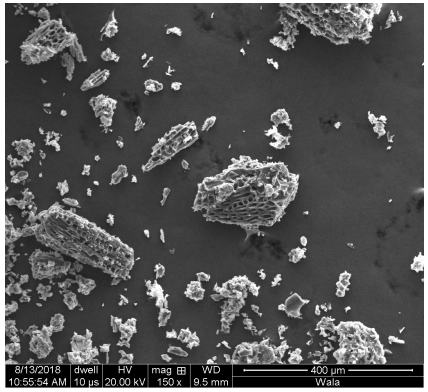


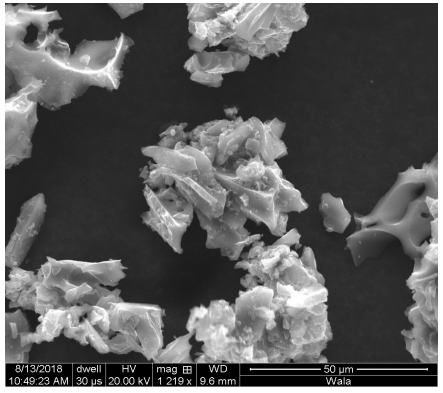


After CO_2 Absorption at 1 bar









Summary

- *In-situ* CO_2 capturing in confined carbon pores holds great promise to increase the kinetics and impart multi-functional properties in concrete
- Started the tasks of Q1
- Preliminary data show promising improvement in concrete's strength
- Treatment of carbon can further improve the properties and CO_2 capture

Future Works: Work on BP1 (milestones 1-3)