Programmable Sealant-Loaded Mesoporous Nanoparticles For Gas/Liquid Leakage Mitigation

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Outline

- Benefits to the Program
- Project Overview
- Technical Status
- Accomplishments to Date
- Synergy Opportunities
- Summary

Benefits to the Program

1) Our technology benefits the CCS program objective[1]:

✓ Works with a variety of CCS storage site material (concrete/cement, rock, metal).

✓ Fills nearly any size fluid escape channel (>50 nm).

✓ Easily integrates into existing remediation procedures.

2) Our technology benefits one of CCS program's main goals[2]:

✓ Programmable for specific conditions (high acidity, etc.).

✓ Designed to seal all types of fluid escape channels for over 99% gas/liquid barrier efficiency.

3) ↑ Durability/Stability = ↓ Cost = $$ Savings

4) Expediting CCS program = Faster reduction in environmental CO_2 = Reduction in Global Warming

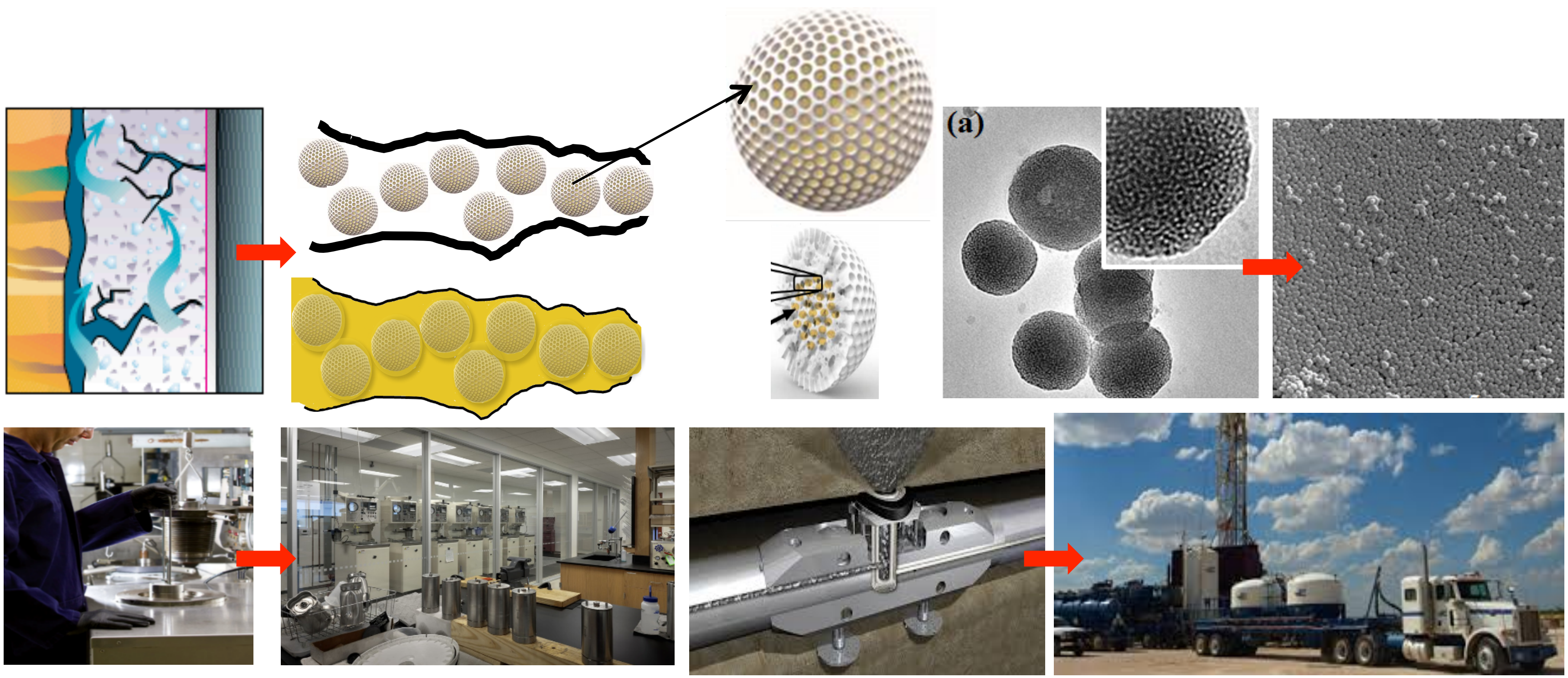
5) Multifunctional technology = Wide applicability = Extension to other industrial sectors (oil, construction, etc.)

[1]DOE's CCS program objective = "To develop and advance technologies that will significantly improve the effectiveness and reduce the cost of implementing carbon storage, both onshore and offshore, and be ready for widespread commercial deployment in the 2025–2035 timeframe"

[2] A DOE's CCS goal = "Develop and validate technologies to ensure 99 percent storage permanence."

Overall Project Goal

To obtain and validate a programmable nanocomposite technology that significantly mitigates wellbore leaks and increases CO_2 reservoir storage efficiency.



Specific Objectives

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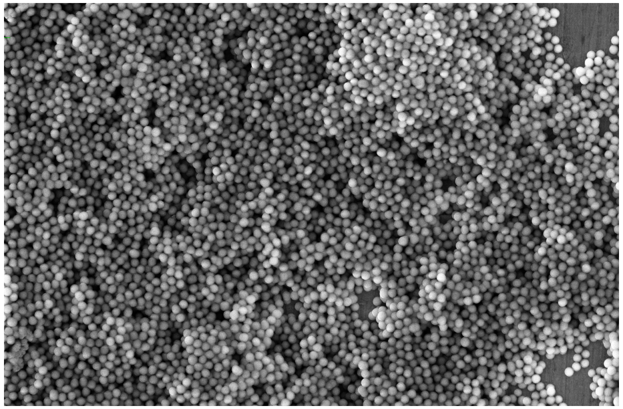
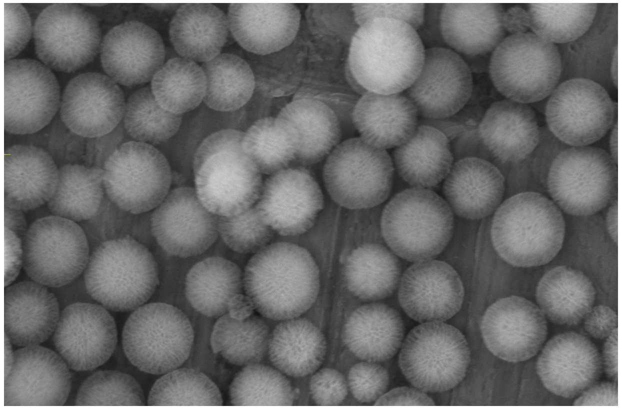
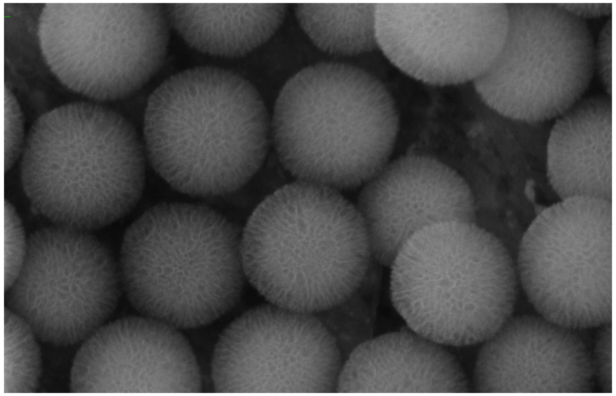
Objective 1: Development and fine-tuning our current prototypal Cement-based Porous Nanoparticles (CPNPs) to offer the best solution to CO_2 leakage in environments with a variety of extreme conditions including high temperature, high pressure, and high acidity.

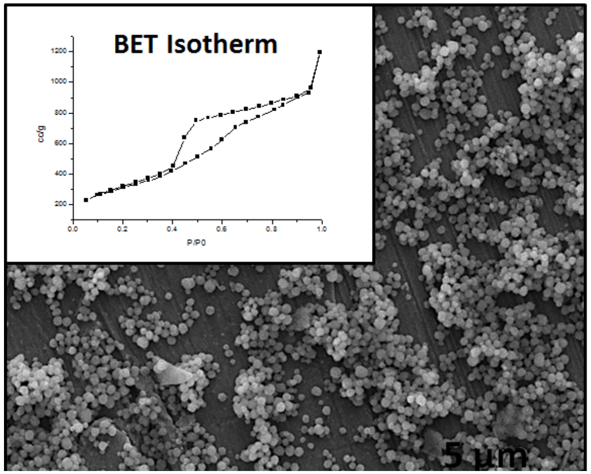
Objective 2: Testing of the actual barrier efficiency inside a simulated environment along with product validation and integration with current (or minimally modified) methods and equipment used for wellbore remediation (field tests).

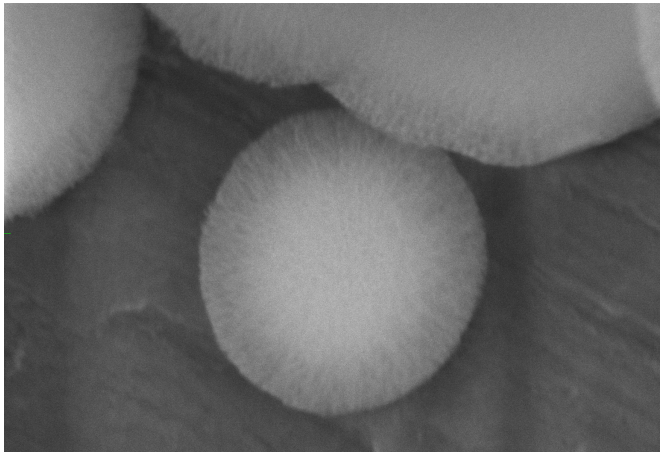
Full Control Over Particle Composition, Morphology, Size,





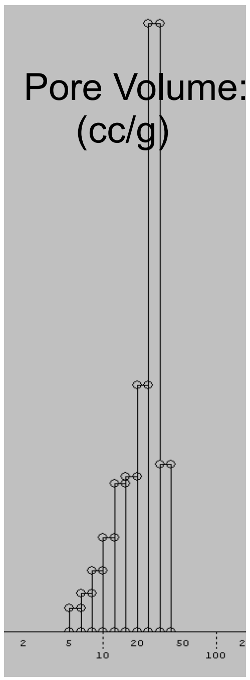




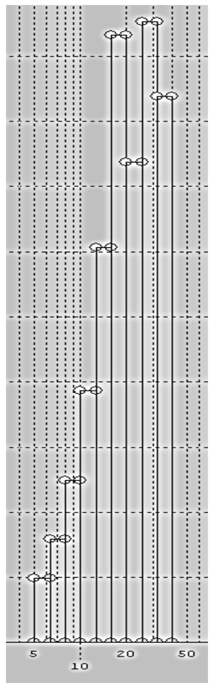


Highly Mono Disperse particles

Structural & Mechanical Characterization



Angstrom



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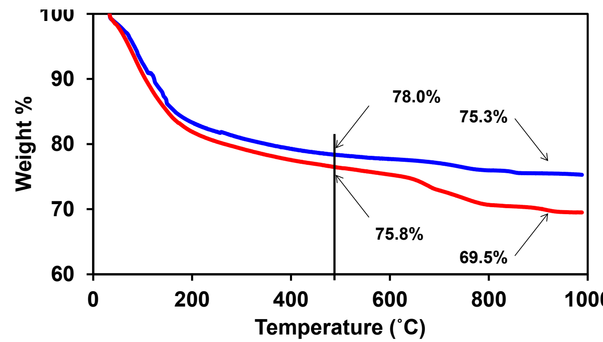
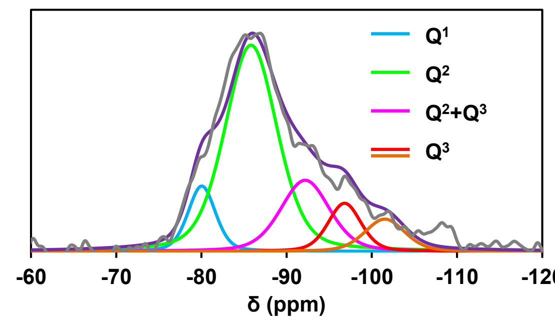
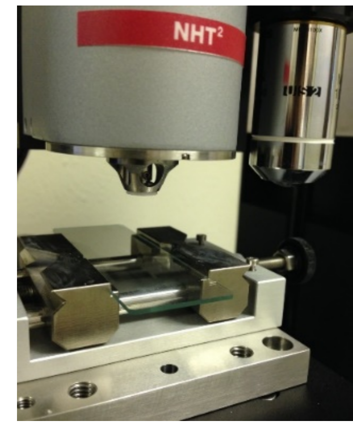
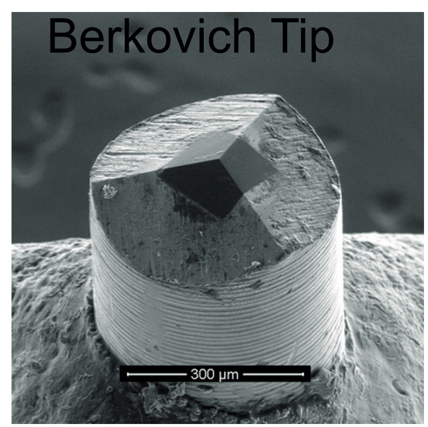
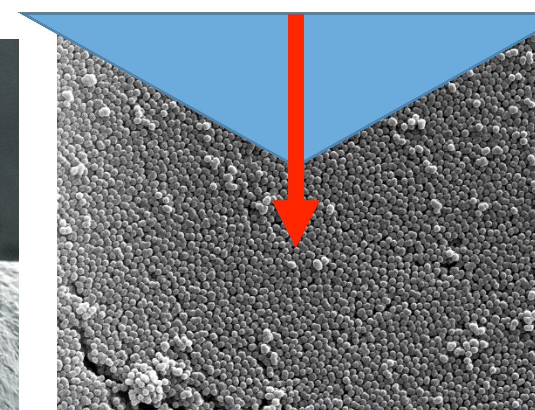


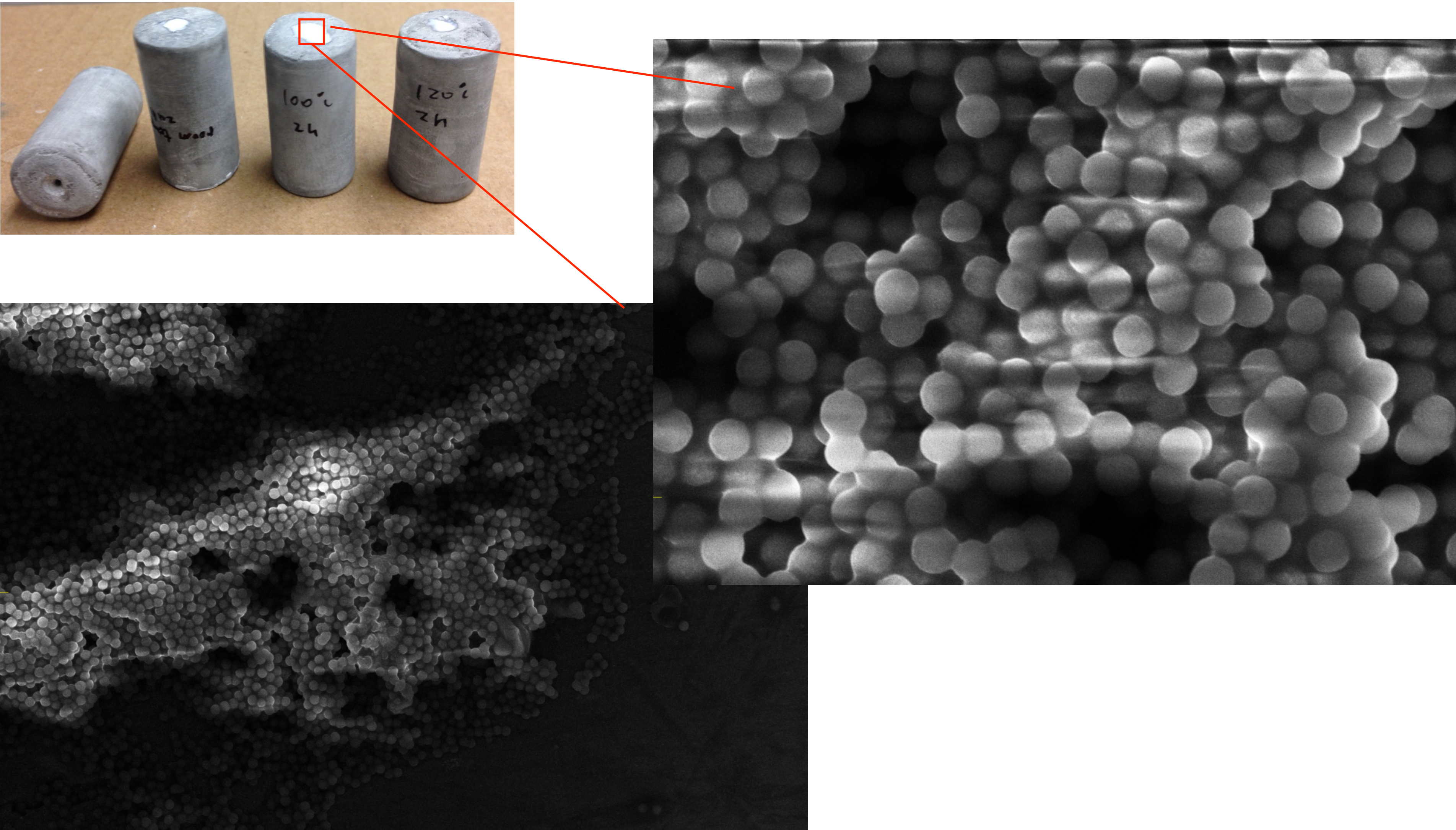








Characterization



Initial viscosity testing

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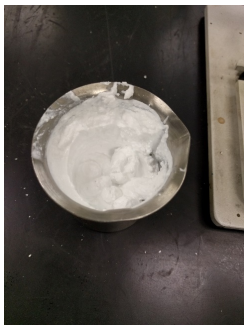

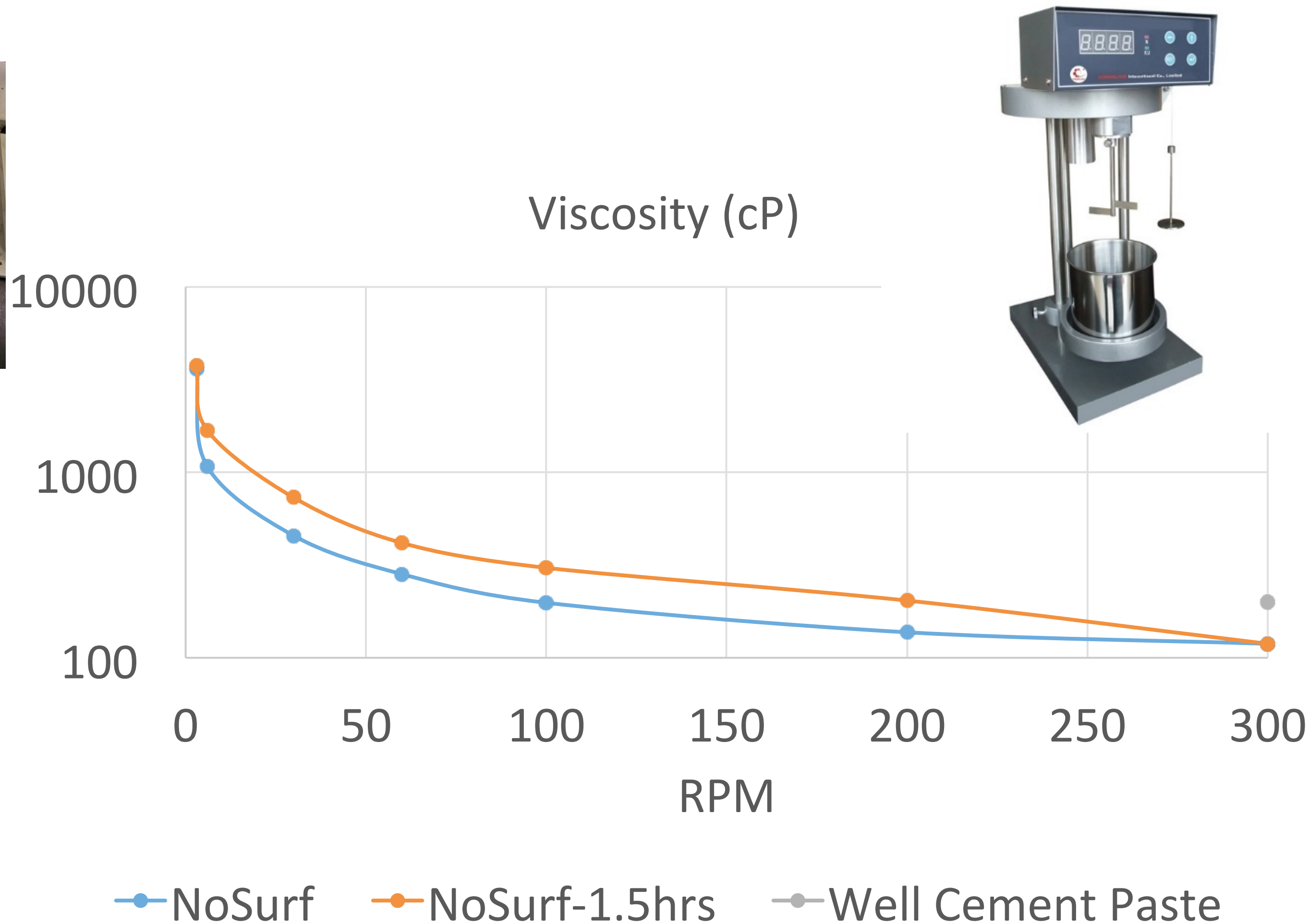

Permeation Testing

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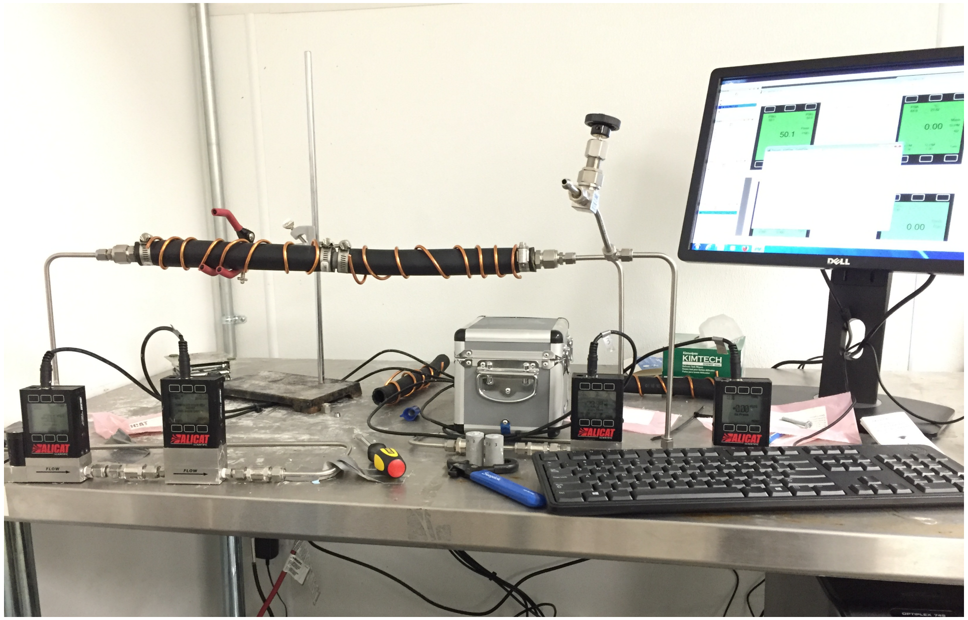
Initial results show promising CO_2 blockage



Accomplishments to Date

- Full Synthetic control over particle size, composition and morphology -> programmable depending on the wellbore needs
- Optimization of the reaction conditions to maximize the product yield
- Successful demonstration of loading and unloading of the optimum sealants exposed to CO_2
- Successful scale up of the reaction

Synergy Opportunities

- Add other nanoparticles (e.g. microbes from Montana State Univ.) to the list of our sealants while providing feedback about the ability and effectiveness of those nanoparticles for sealing CO_2 under wellbore conditions

- Take the lessons from the nanoparticle injection technology of Univ. of Colorado to better strategize our injection protocol

Summary and Future Work

- Developed a lab-scale programmable hybrid sealant nanocomposite to mitigate CO_2 leakage in existing wells of CCS sites.
- Able to produce various CPNP particles with multiple pore sizes→ a wide range suitable for various sealants and wellbore conditions
- Successful loading and unloading of the sealants to prevent CO_2 scape

Future Work:

- Investigate activation with other stimuli
- Scale-up the reaction for large-scale demonstration, followed by pilot-scale field test