Silanes on Sand Aggregate Improve Concrete’s Early Strength
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Concrete: Why Early Strength?
Application: Home and building foundations, concrete molds
Problem: Current Concrete does not last and produces 8.6% of CO₂ emissions.¹

Long Term Goals:
- Greener city and community infrastructure
- Self-Healing, Carbon-Negative Concrete

Summer Reasearch Goals:
- Understanding Concrete Surface Chemistry
- Exploring Silane and Zn(Cyclen) functionalized concrete

The Cast: Silanes Attached to Sand
GPTMS binds to Sand
H₂O + CO₂ → CO₃²⁻ + 2H⁺
Epoxy Ring Opens
Zn(Cyclen) Binds
Converts CO₂ to CO₃²⁻

Concrete Strength Questions
What structurally is causing increased strength in epoxy terminated silane GPTMS?
Does Zn(Cyclen) GPTMS tethered have greater early strength than other samples?

Methods
1st Piranha Cleaning Sand & Glass
- 3:1 18M H₂SO₄ & 30% H₂O₂
- Cleans off Organics!

Silanize in Sonicator

2nd Silane Treating Sand & Glass
- 4 hr sonication in silane solution
- Binds Silane to sand surface!

Epoxy-terminated silane...
yields high strength

The Motive: Concrete Strength Tests
Compressive Strength of 14 Day Cure of Treated Sand Samples

Exploring Early Concrete Strength of Zn(Cyclen) Tethered GPTMS Sand

The Big Picture: Zn(Cyclen) Tethered GPTMS Sand

SEM of Concrete using GPTMS bound Zn(Cyclen) to Sand Surface
SEM of Concrete using Unwashed "Dirty" Sand

Aragonite
- Calcium Carbonate Crystal Structure
- Same as produced by Carbonic Anhydrase and Zn(Cyclen)

C₃S
- Gives concrete its strength in early phase of cure

CSH
- Calcium silicate hydrates
- Gives concrete its strength²

Ettringite
- Calcium Aluminum Sulfate
- Found in Portland Cement
- Leads to cracking in concrete

C₃S
- Gives concrete its strength in early phase of cure

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UN Goals: Classroom Connections
Purifying Water:
A Separation of Mixtures Lab
- Can students design a water purifying techniques from an impure water sample?
- Culmination of Gen Chem lab techniques
- Using Physical & Chemical Properties
- Explore water purity issues world-wide

Acknowledgments & References
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References: