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The Cure for Concrete Cancer

An Overview of Self-Healing Concrete Technology

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3 BIG THINGS

Abstract

Problem

Cracks in concrete are unavoidable, and they allow water seep into the reinforced steels and cause oxidation, which is referred to as “concrete cancer.” The cancer decreases concrete lifespan and endangers the structures.

Solution: Bacterial Self-Healing Concrete(SHC)/ “Bio-concrete”

- 1.Improves safety: auto-repairs cracks that form
- 2.Reduces cost: manual repairs, unnecessary over-dimensional design
- 3.Reduces global carbon dioxide emission (e.g. Increases concrete lifespan, reduces annual amounts of concrete production) [1].

Key Findings

Self-healing concrete technology seeks to mimic a natural process called biomineralization to increase the lifespan of concrete structures.

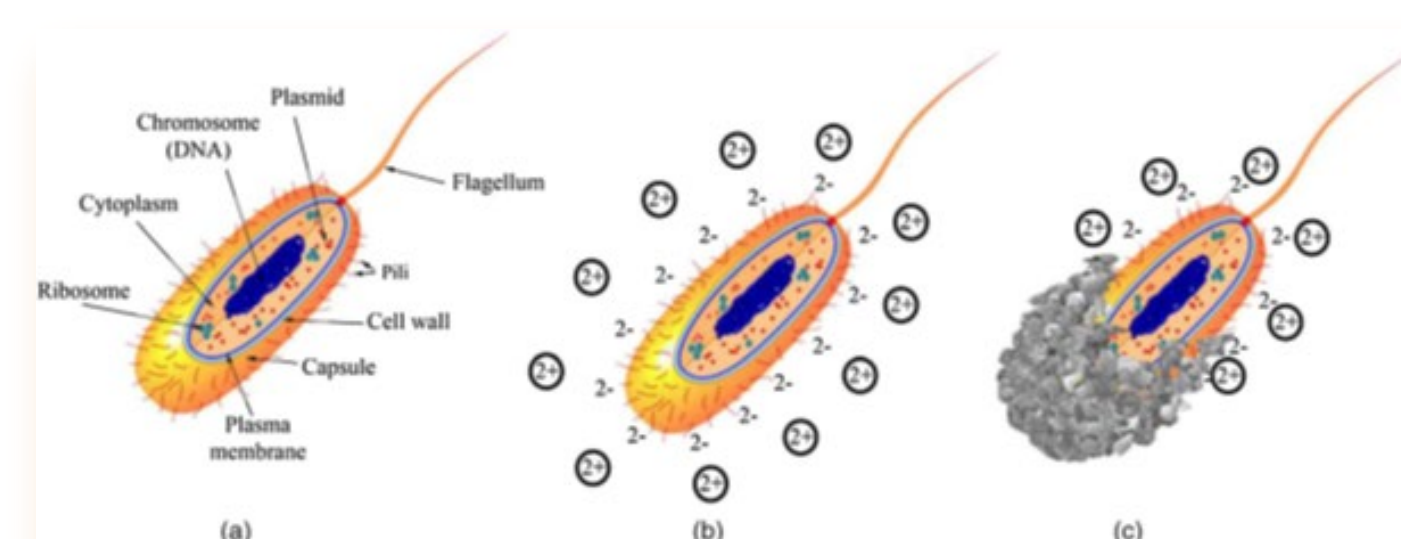


Fig. 1. (a) Bacteria structure; (b) negatively charged cell wall and positively charged ions; and (c) biomineralization by means of bonding ions to cell wall. (Reprinted with permission from Springer Nature: Springer, Applied Microbiology and Biotechnology, “Bioconcrete: next generation of self-healing concrete,” M. Seifan, A. Khajeh Samani, and A. Berenjian, © 2016.)

Bacterially activated crack repair is significantly more efficient than similar unsupplemented natural processes

Figure 2. Self healing admixture composed of expanded clay particles (left) loaded with bacterial spores and organic bio-mineral precursor compound (calcium lactate). When embedded in the concrete matrix (right) the loaded expanded clay particles represent internal reservoirs containing the two-component healing agent consisting of bacterial spores and a suitable bio-mineral precursor

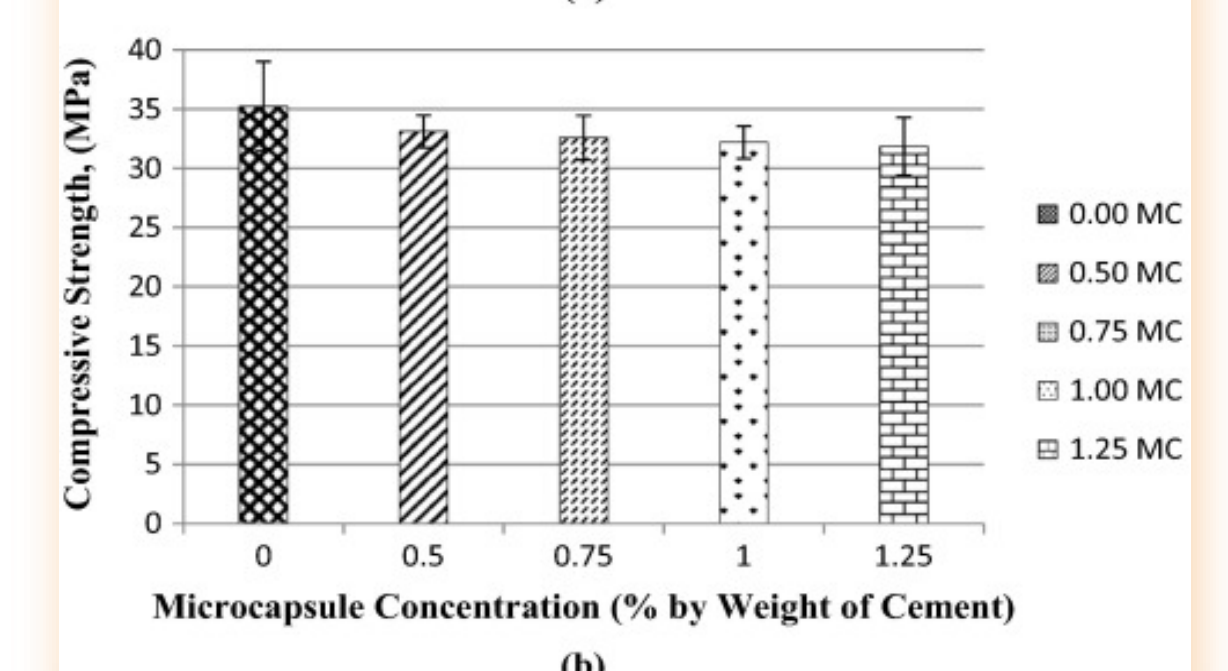
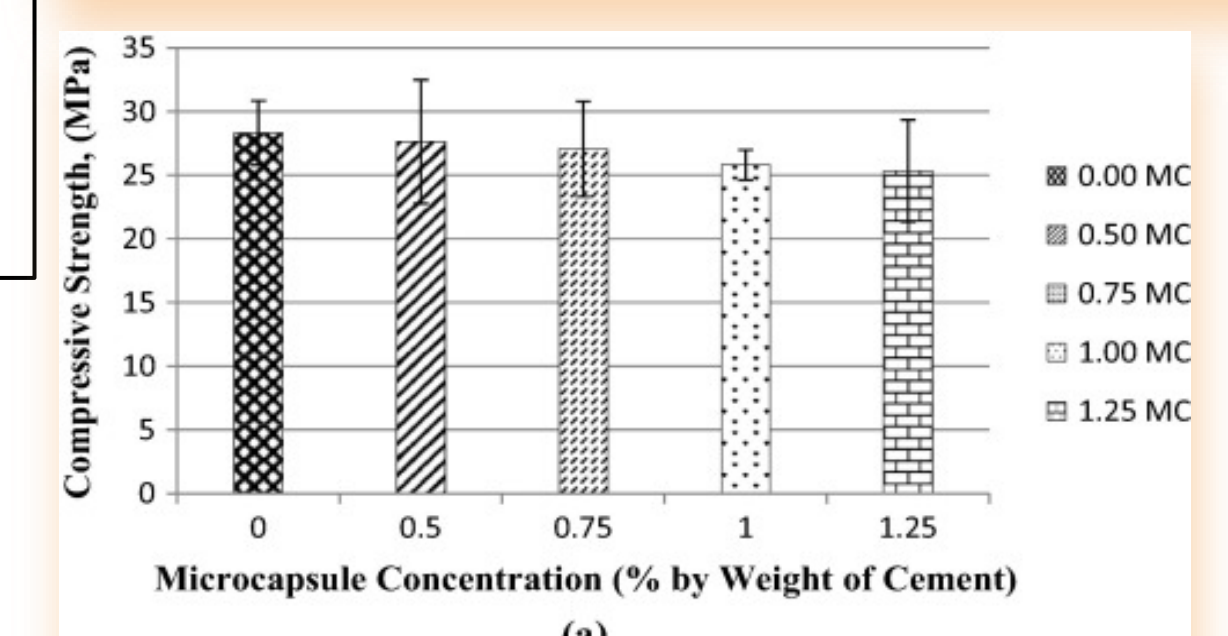


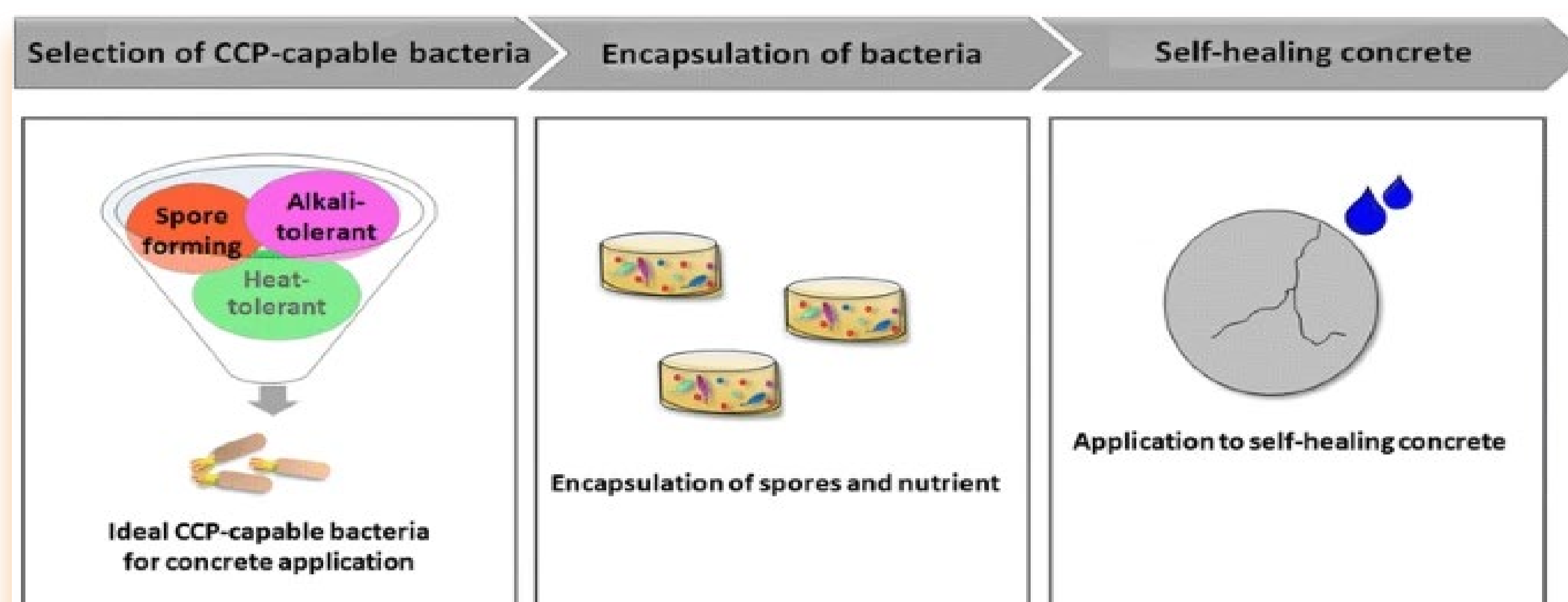
Fig. 3. **Compressive strength** versus microcapsule concentration (a) at 7 days, (b) at 28 days (Error bars = standard deviation).

Microcapsule inclusion in the concrete matrix results in a moderate reduction in strength. However new research promises to diminish that effect.

- **Self-Healing Concrete is an Economical Long-term Solution for Concrete Cancer**
 - With improved encapsulation techniques and optimized bacterial mixtures on the horizon, SHC will soon be cost competitive [3]
- **Biomineralization Improves When Paired with Green Technology**
 - Research shows added fly ash lowers pH while increasing bacterial activity providing both economic and environmental benefits [4]
- **Multiple Diverse Benefits From One Technology**
 - Economic benefits from lowered maintenance costs and extended lifespan
 - Environmental benefits from reduced carbon emissions
 - Safety benefits from improved integrity

How it works!

- ❖ The bacillus bacteria and nutrients (capsules of calcium lactate) are embedded inside the conventional concrete mixture.
- ❖ When a crack appears, water ingression activates the bacteria. The bacteria begins interacting with calcium lactate producing calcium carbonate.
- ❖ Continued precipitation of calcium carbonate/limestone occurs, which helps fill space between the cracks [2].



Acknowledgements

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Future Work

- Research to optimize bacterial, nutrient mixture
- Directed research towards economical encapsulation methods
- Improved application of biomineralization techniques on pre-existing structures
- Research optimum combination of green and self-healing concrete technology

References

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