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Chemeca 2026 and Hazards Australasia
28 – 30 September, Melbourne, Australia

Enhanced Kinetics of CO_2 Mineralisation in Iron-based Cement

Chichi Zhang, Johann Land, Matthew Watson, Ben Yin, Matthew Cowan

Chemical and Process Engineering, University of Canterbury

Chichi.zhang@canterbury.ac.nz

ABSTRACT

Building materials can be engineered to enable permanent CO_2 sequestration, offering a promising pathway towards reducing carbon footprints. The emerging iron-based cement removes CO_2 through a carbonation reaction that forms a binder material – siderite (iron carbonate). An increase in the siderite content correlates with higher compressive strength, demonstrating the potential of iron-based cement in construction applications. There are two coupled processes governing cement densification: (i) continuous iron corrosion and dispersion of Fe^{2+}-containing corrosion products, which sustain siderite precipitation, and (ii) siderite growth on the surface of non-iron components as nucleation sites. However, the curing regime is limited by the slow kinetics of siderite formation. In this study, we develop new strategies to shorten the carbonation duration by using highly amorphous iron as a reactive material and by introducing zeolite 13X as an additive. These components enhance iron dissolution and facilitate the distribution of corrosion products within the cement matrix. Together, the findings in this work open new avenues for refining formulations of the iron-based cement to maximise carbonation efficiency and accelerate strength development.

KEY WORDS

Iron-based cement, siderite, iron corrosion, zeolite 13X, amorphous iron

BIOGRAPHY

Dr Chichi Zhang is a postdoctoral research fellow in the Department of Chemical and Process Engineering (CAPE) at the University of Canterbury, New Zealand, where she conducts research on CO_2-storing iron-based cement. She received her PhD from CAPE, University of Canterbury and Bachelor's degree in Materials Science and Engineering from Tongji University, China. She specialises in advanced materials characterisation and engineering with publications in prestigious scientific journals such as *Energy* and *International Journal of Hydrogen Energy*.

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