Morphology and polymorphism of calcium carbonate precipitated from different calcium sources via enzyme induced carbonate precipitation

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Enzyme induced carbonate precipitation (EICP) is a biomineralisation process, in which plant-derived urease enzyme is used to hydrolyse urea and precipitate calcium carbonate ($CaCO_3$). In this study, plant-derived urease from common jack bean (*Canavalia ensiformis*) was used to precipitate $CaCO_3$ via EICP. Three different calcium sources were used, i.e. calcium chloride ($CaCl_2$), calcium lactate and dissolved chalk solution that was prepared by dissolving chalk in lactic acid.

Real-time monitoring of the $CaCO_3$ precipitation and crystal growth was performed for up to 72h using an optical microscope. Structure and morphologies of the $CaCO_3$ crystals were further characterised via Raman spectroscopy and scanning electron microscopy. Different morphologies of $CaCO_3$ crystals were observed. The sample with $CaCl_2$ was dominated by calcite crystals of typical rhombohedral morphology. Spherical shape calcite as shown in Figure 1 was observed in the sample containing lactate.

Similar EICP systems were applied to consolidate sand grains. Morphology and structure of the precipitated $CaCO_3$ can have a substantial impact on binding efficiency and properties of the final consolidated product. Mechanical properties of the consolidated sand were evaluated through compression test. X-Ray diffraction analysis was performed to identify different crystals formed in the sample. This study is vital to give a better understanding of the relationship between different calcium sources and morphologies of the precipitated $CaCO_3$ by visualising the process, and their effects on the consolidation efficiency.

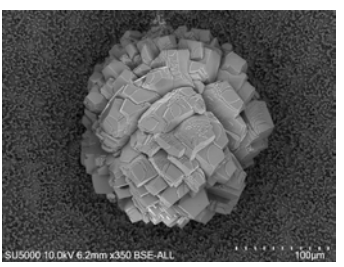

Figure 1: Spherical shape calcite from the sample with calcium lactate