Biosilica encapsulation of carbonic anhydrase for environmental applications

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Carbonic anhydrase (CA) is a biocatalyst for CO2 sequestration because of its distinctive ability to accelerate CO2 hydration. High production and immobilization of alkaline-active functional CA are required for practical application of enzymatic CO2 capture system. In previous report, α type-CA (HC-aCA) of Hahella chejuensis KCTC was mostly produced as insoluble form in E. coli expression system. Here, by removal of the signal peptide (SP), we successfully set up soluble expression systems. HCA(SP-) also displayed high pH stability in alkaline conditions, with maximal activity at pH 10; at this pH, 90% activity was maintained for 2 h. Then, we prepared HCA(SP-)-encapsulated silica particles [HCA (SP-)@silica] via a spermine-mediated bio-inspired silicification method. HCA(SP-) @silica exhibited high-loading and highly stable CA activity. In addition, HCA(SP-)@silica retained more than 90% of the CA activity even after 10 cycles of use in mild conditions, and 80% in pH 10 conditions. These results will be useful in the development and improvement of practical CA-based CO2 sequestration processes.