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Bio-active self-healing cement in oil well applications

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The application of bio-active self-healing cement aims to apply a microbially-engineered system for *in-situ* calcium carbonate precipitation in deep sub-seafloor environments to prevent the development of microstructural cracks during the lifecycle of the cement that could potentially compromise the integrity of the well-construction. We will present results showing the feasibility of using alkaliphilic *Bacillus alkalinitrilicus* bacterial spores along with its nutrients and calcium source (calcium lactate) impregnated into lightweight expanded clay aggregates (LECA). Such pre-prepared bio-active LECA can be easily mixed into the cement mix for obtaining self-healing properties in the field. Size fractions and percentages by weight of cement of LECA beads have been tested and optimized to achieve the maximum self-healing capacity without compromising the compressive strength of cement paste. Furthermore, ideas for upscaling the impregnation process to bigger quantities has been considered. Key findings of the bio-active self-healing cement with embedded LECA beads were demonstrating promising results, including microcrack filling with bio-mineral calcium carbonate grown from the cement paste being observed both by optical light-microscopy and scanning electron microscopy in different scales; non-destructive micro x-ray computed tomography could visualize for the first time the crack self-healing repairing phenomenon at sub-micron scale. Permeability tests on the specimens with single cracks that range in width from 120 to 190 µm, evaluate the self-healing efficacy that the bio-active self-healing cement could seal the crack occurred as early as 3 days.

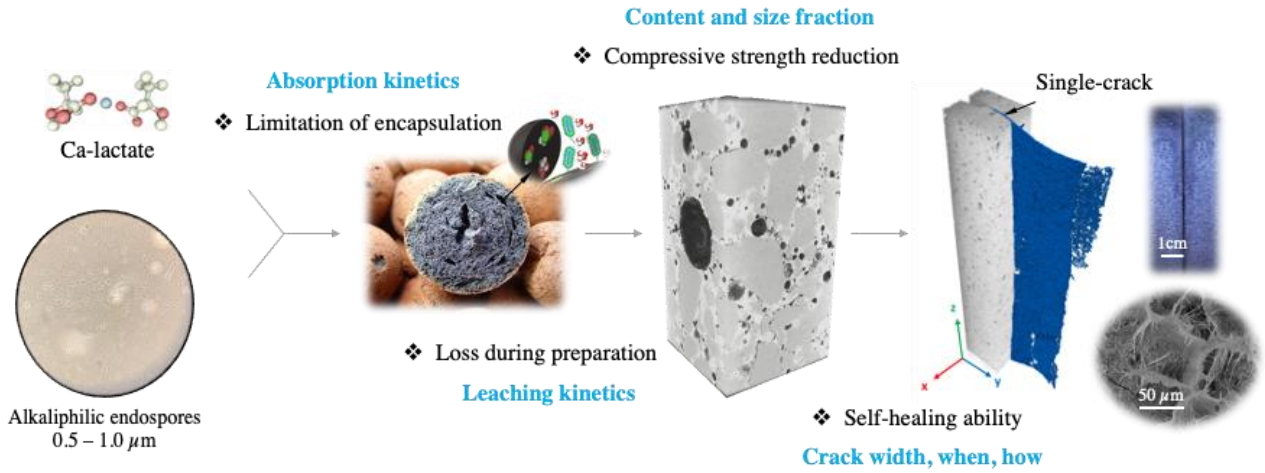

Figure 1: Schematic of a bio-active self-healing cement for *in-situ* self-healing of microstructural cracks in cementitious materials.

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