Development of a microdevice for understanding the mechanisms of biocementation in soils

Proposers

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Introduction

Microbial-induced carbonate precipitation (MICP), or biocementation, is an *in situ* soil strengthening technique that uses ureolytic bacteria to induce calcium carbonate precipitation. The correct combination of physical and chemical parameters to control MICP is still a major challenge. This proposal aims to develop a lab-on-a-chip device capable of screening the large number of parameters that influence MICP by combining the consolidated know-how in microfluidic and biosensor platforms at INESC-MN, and expertise in the fields of mechanical stability of soils at CERIS, IST, and in biotechnology at IBB, IST. The proposed device will integrate an electronic readout, for feedback control of the critical parameters. The knowledge earned will provide valuable information to design soil improvement solutions using this technique, namely in the influence of soil grain surfaces on bacteria adhesion.

Project outline/goal

This proposal describes the development of a compact and portable system for monitoring MICP in soils, using integrated technologies such as microfluidics and microsensors. Among the most important factors to be studied are the grain surface properties to promote bacteria adhesion, number of bacteria, the type, concentration and feeding rate of nutrients and time necessary to achieve the desired result.

The device will be designed to mimic flow through the pores of granular soils, in which surfaces will be changed simulating different textures and chemical properties of soil particles. The device will be supplied with bacteria and nutrients/reagents by inlet channels. For temperature and pH control, commercially available sensors will be integrated. Integrated biochip sensors for carbonate, ammonium and urease will be developed in-house, when deemed necessary. Bacteria growth and changes in flow characteristics will be monitored, as they are modified as function of the amount of carbonate precipitation. The proposed device will integrate an electronic readout, for feedback control of the critical parameters.

Additionally, once proof-of-concept has been established, the device will be used to determine the best set of conditions to produce the maximum amount of biocement for a specific surface type through trial tests performed under optimized conditions.

Student profile

Profile sought: preference, but not limited, to students with a background in Biotechnology, Biology and Biochemistry, with interest in surfaces and material characterization and in the development of microdevices and electronics.