Thesis project: **Binders for sustainable concrete: testing for dissolution and precipitation**
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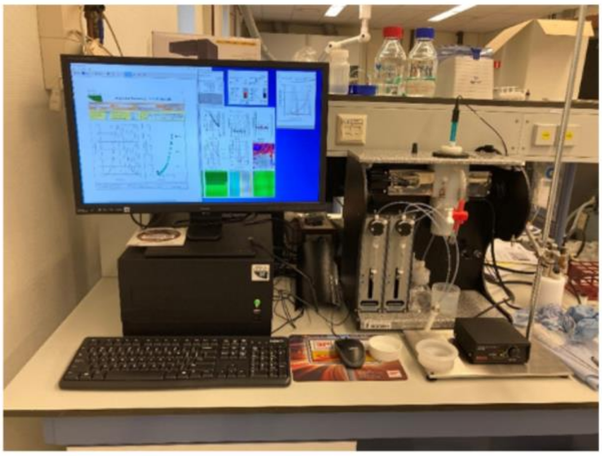
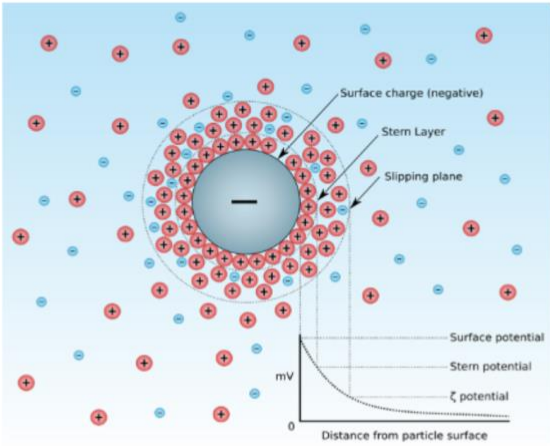
- Department: Process & Energy, 3mE
- Theme: Process Technology
- Is an external organization involved? TNO - Lab for Materials, Energy and Construction
- The thesis involves: Experiments
- Prerequisite: some hands-on lab experience

In order for the building industry to become more sustainable, especially the cement production has to be reconsidered since it is responsible for more than 5% of the annual CO_2-emission worldwide. A promising way to reduce this footprint is by replacing traditional cement by alternative binders from secondary (aluminium-silica) materials such as fly ashes and blast furnace slag. However, these materials have as disadvantage that they do not spontaneously dissolve and harden when mixed with water like cement does. Instead, they have to be activated chemically. Although successful activators for the so-called geopolymer binders have been developed, these activators currently also have a high CO_2-footprint.

The high pH of the geopolymer slurries under investigations have large negative surface charges that prevent precipitation. Adding sufficient counter-charged ions may neutralize these surfaces, making phenomena like aggregation possible. However, over-dosages may flip the system to the opposite charge, again preventing the material to harden.





In this project, you will investigate how the solid surface changes with solution composition both in terms of electric charge and adsorbed/desorbed materials and how phenomena like back-precipitation or charge reversal (and thus inhibition of further hardening) can be prevented. This can be achieved in part via (electro-) acoustic zetapotential measurements. Simultaneously monitoring electric conductivity, pH and calcium-concentrations as well as measuring adsorbing/desorbing components in situ gives a unique possibility to make a concise experimental verification of the processes at the solid surface, in relation with the solution. To this aim, you will execute tests in which characteristic model parameters will be defined and followed.

The research will take place at the TNO Lab for Materials, Energy and Construction in Delft and be conducted in co-operation with the Process & Energy Department at TU Delft. Ultimately, the goal of the project is to investigate the electric double layer around aluminium-silica materials such as slag and fly ashes at high solid-liquid ratios with the purpose of developing sustainable building materials.