# Atomic Force Microscopy (AFM)

EMPA
Materials Science & Technology

**Author: Lucia Ferrari**
Contact: lucia.ferrari@empa.ch

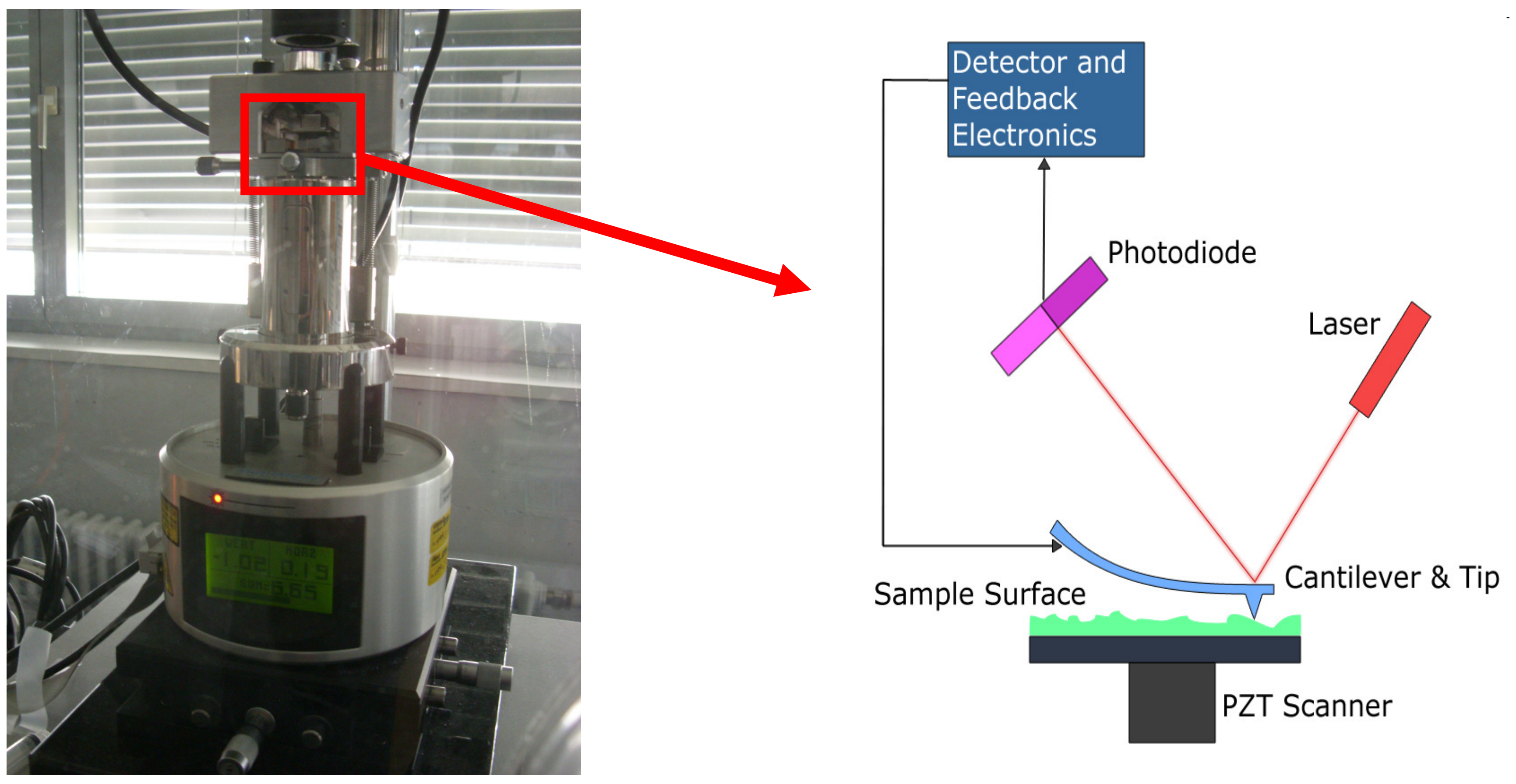
## Introduction

The atomic force microscope (AFM) is a very high-resolution type of scanning probe microscopy, with demonstrated resolution of fractions of a nanometer. This is one of the foremost tools for imaging, measuring, and manipulating matter at the nanoscale level.

The AFM provides a true three-dimensional surface profile, and samples viewed by AFM do not require any special treatments, like metal/carbon coatings, that would irreversibly change or damage the sample.

The information about the substrate is generated by the interaction between the surface and a mechanical probe positioned in the top of a cantilever.

## Measurement Principle



When the tip is brought into proximity of a sample surface, forces between the tip and the sample lead to a deflection of the cantilever, which gives information about substrate topography and allows direct measurements of the force between the tip and the substrate.

## Relevance for Our Field

AFM allow to:

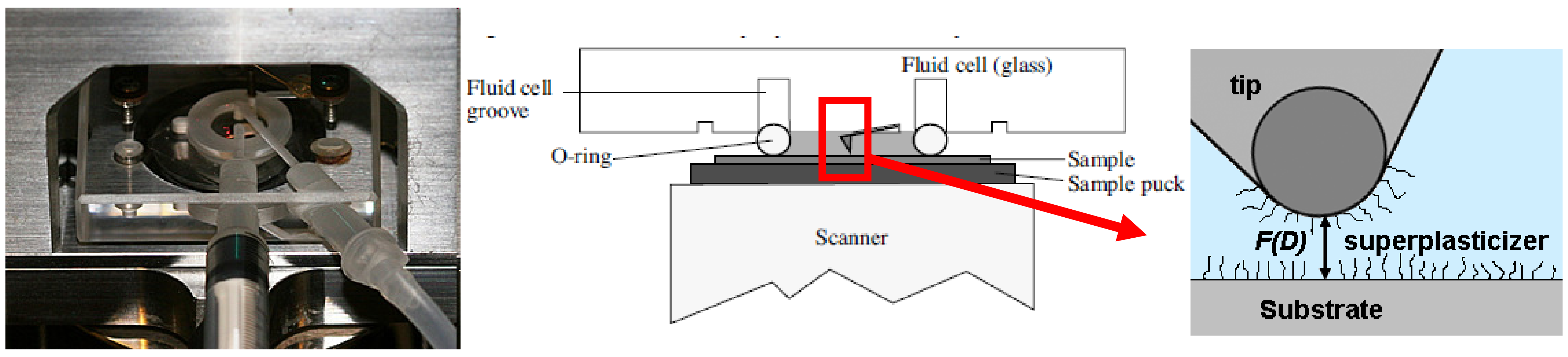
- measure the force of the order of nanonewton between the tip and the substrate;
- scan images of substrate with a nanometric resolution.

Application to cement:

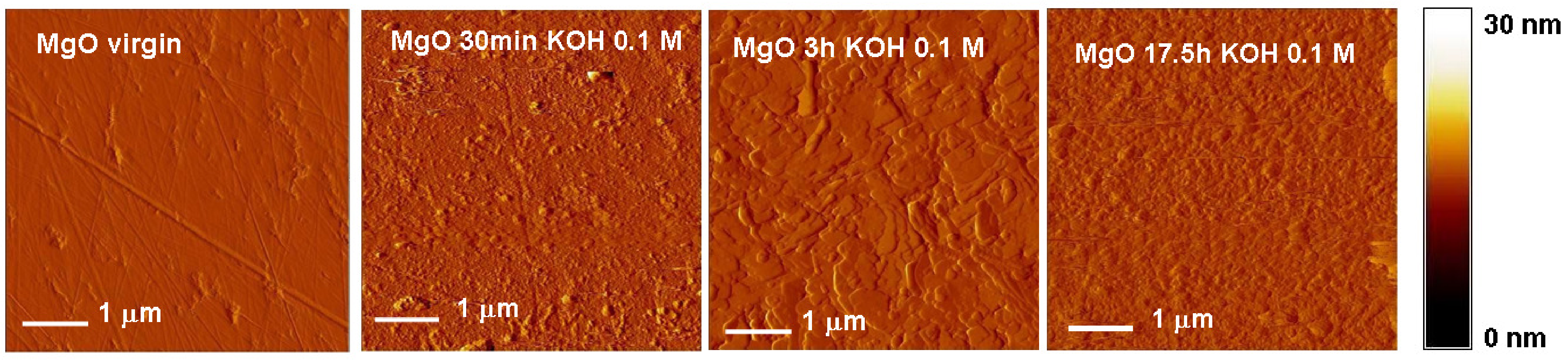
- measure the dispersion force due to superplasticizers working in liquid environments;
- quantification, on nanoscale level, of the roughness change of a substrate depending on different times of immersion.

## Example

Force measurements in liquid environments:

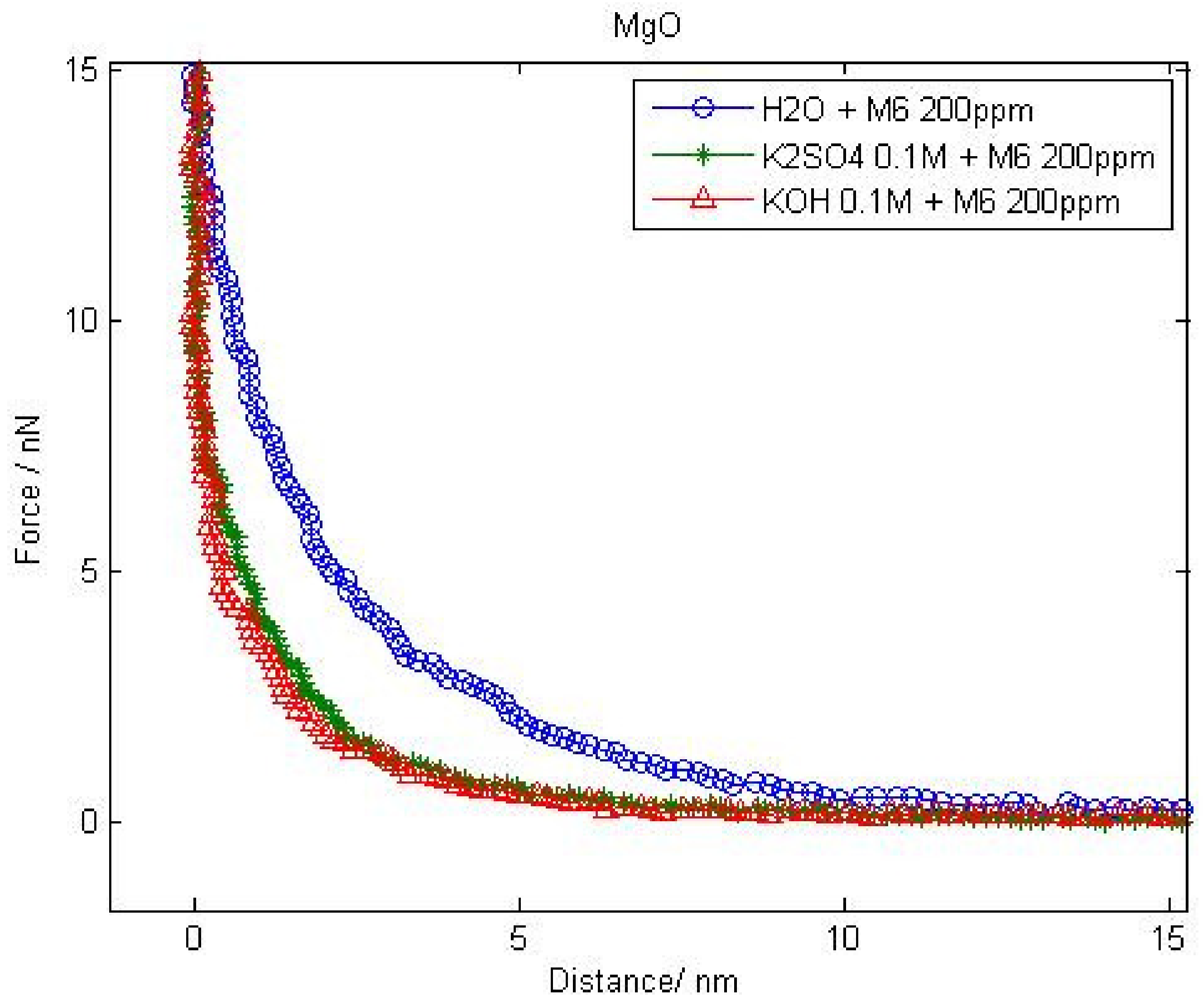


Chemical interaction (reaction/dissolution):

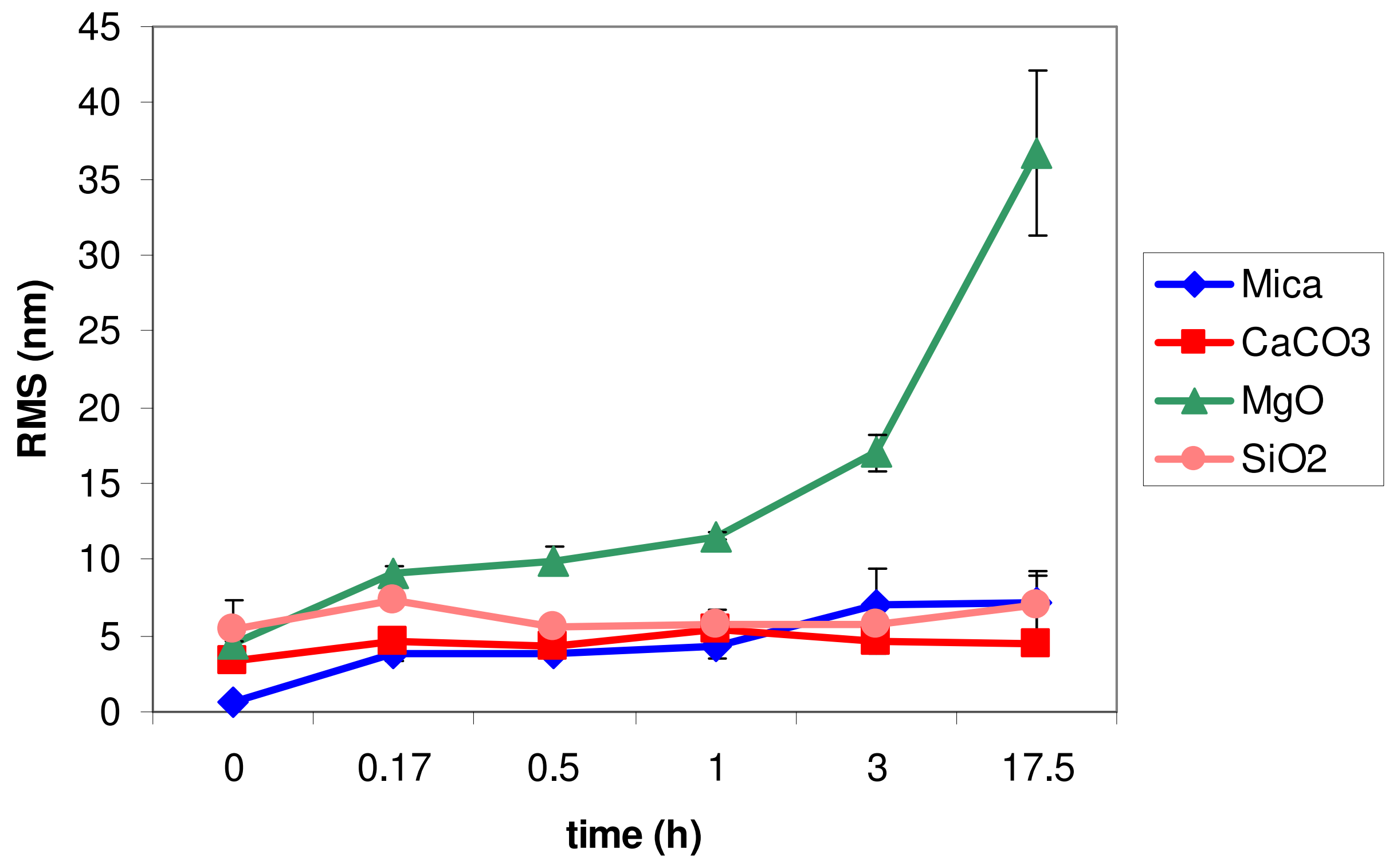


## Applications & Potentials

Force measurements:



Chemical interaction:



Root mean square: $RMS = \sqrt{\dfrac{\sum_{i=1}^{N}(Z_i - Z_{ave})^2}{N}}$

## Limitations

- Images: it is not possible to collect information about the chemistry of the substrate while scanning the surface.
- Force measurements: cement is reacting extremely fast with water, so that model systems are required to afford reliable results.

**EMPA Concrete / Construction Chemistry Laboratory**