Civil and Environmental Engineering

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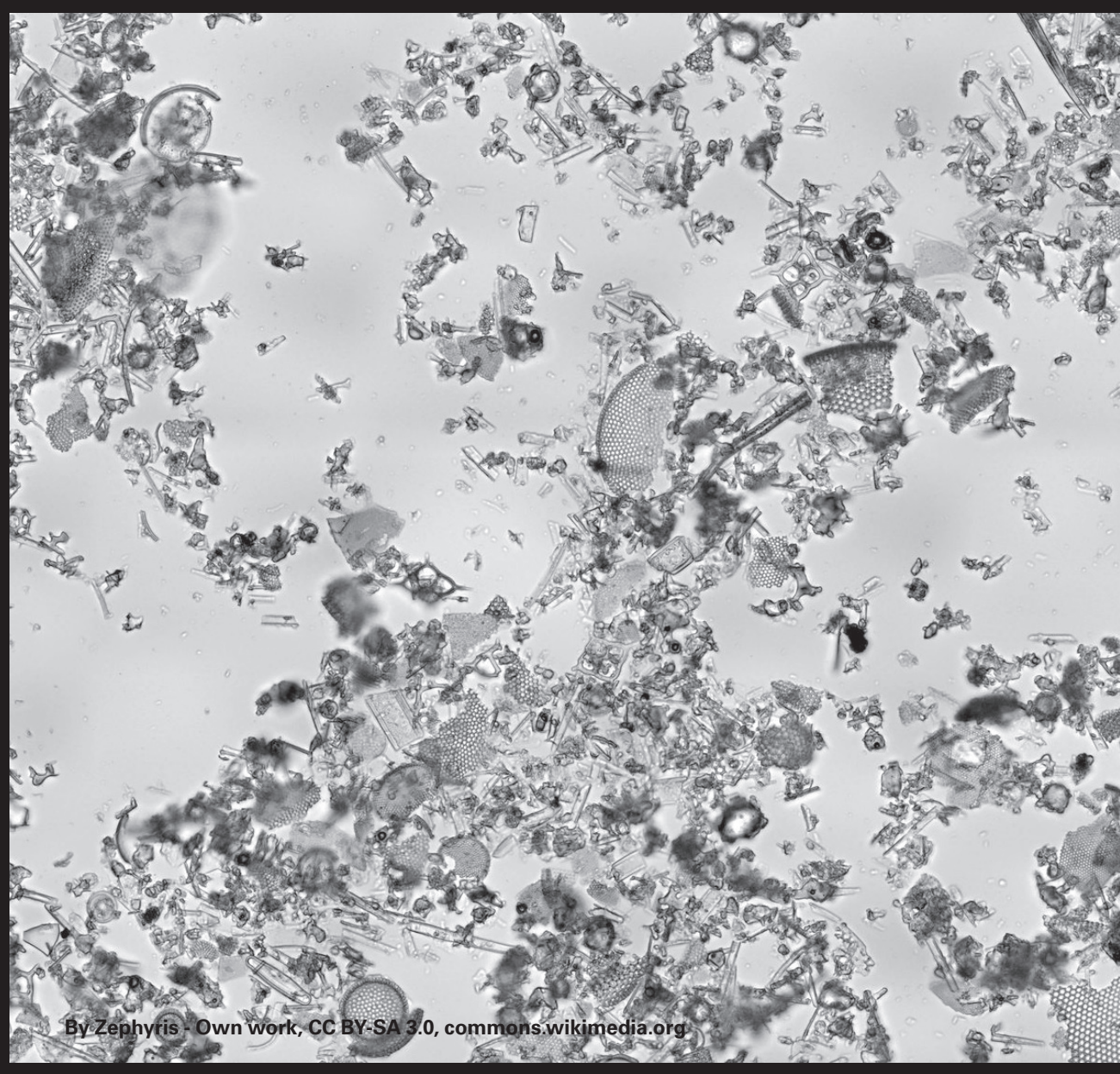
SOFT MATTER IN CONSTRUCTION: COMPUTATIONAL STATISTICAL PHYSICS OF SUSTAINABLE CEMENTS

ABSTRACT

More than 20 billion tons of concrete are produced every year, more than any other material on Earth, such that concrete production is responsible for 10% of the whole anthropogenic production of CO2. Reducing CO2 emissions for concrete production is hence essential to meet Greenhouse Gas reduction targets. Strength and other mechanical properties of concrete rely upon cement (its main binding agent) and the formation/gelation of calcium–silicate–hydrates (C–S–H) during cement hydration. Controlling structure and properties of the C–S–H gel phase is a challenge, due to the complexity of this hydration product and of the mechanisms that drive its precipitation from the ionic solution upon dissolution of cement grains in water.

Lack of scientific insight into structure and mechanics of C-S-H has been for a long time a major obstacle to developing novel green formulations of concrete. Nevertheless in recent years electron microscopy imaging, nano-indentation tests, X-rays and neutron scattering, and NMR analysis as well as atomistic simulations have elucidated several structural and mechanical features concentrated within a few nanometers. A potential breakthrough has been combining such experimental insights with novel fundamental understanding gained through modeling and numerical simulations, which use statistical and condensed matter physics approaches to tackle the structural and mechanical complexity of the material over critical lengths-cales. These achievements provide a novel opportunity to scientifically design cement material properties and hence identify strategic issues that have the potential to transform cement production and use.



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APRIL 24, 2017

Pre-lecture Reception: 4:30pm
Lecture: 5-6pm
Building 1-190

FACULTY HOSTS:

Lydia Bourouiba,
Roland Jim Pellenq,
and Franz-Josef Ulm

BIOGRAPHY

Prof. Emanuela Del Gado is a theoretical physicist working on engineering motivated problems. She uses statistical mechanics and computational physics to investigate materials with structural and dynamical complexity, from model amorphous solids, gels and glasses, to new green formulations of cement. In 2017, Emanuela Del Gado was named a 2017 Provost's Distinguished Associate Professor. The honorific title recognizes Prof. Del Gado for excellence in research and teaching. Her work on "green concrete" has widespread practical implications for reducing energy consumption in the production of concrete.

Prof. Del Gado received her undergraduate degree (Laurea in Physics, cum laude) at the University of Naples "Federico II" in Italy, where she also obtained a PhD in Physics in 2001. She has been a Marie Curie Fellow at the University of Montpellier II in France and a post-doctoral researcher at ETH Zurich in Switzerland, and hold visiting positions at ESPCI (France) and MIT. Before joining Georgetown University, Emanuela was the Swiss National Science Foundation professor in the Department of Civil Environmental and Geomatic Engineering at ETH Zurich.

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