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Heterogeneous Glasses and Sustainable Cement

EMANUELA DEL GADO, Georgetown University

Calcium-silicate hydrate (C-S-H) is the main binding agent in cement and concrete. It forms at the beginning of cement hydration, it progressively densifies as cement hardens and is ultimately responsible for the performances of concrete. This hydration product is a cohesive nano-scale heterogeneous glass, whose structure and mechanics are still poorly understood, in spite of its practical importance. I will review some of the open questions for this fascinating material and discuss a statistical physics approach recently developed, which allows us to investigate the structural arrest and solidification under the out-of-equilibrium conditions typical of cement hydration and the role of the nano-scale structure in C-S-H mechanics upon hardening. Our approach unveils how some distinctive features of the kinetics of cement hydration can be related to changes in the morphology of this glassy material and elucidates the role of nano-scale mechanical heterogeneities in the hardened C-S-H.