THE UNIVERSITY OF CONNECTICUT
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Investigating High Energy Mixing in Cement-Based Materials

ABSTRACT

One of the current challenges to nano-engineering cementitious composite materials is obtaining properly dispersed nano-sized particles in the cementitious composite matrix. Properly dispersed nanoparticles can lead to an improved particle packing density, a key parameter to improving the mechanical, chemical, and sustainable properties of the cementitious composite. Broadening the particle size distributions of cementitious materials, such as ultra-high performance concrete (UHPC), to include additional nano-sized particles is a challenge that requires a better understanding of how they self-assemble in the cementitious matrix. Thus, the purpose of this research is to investigate the role mixing plays in multi-scale, multi-phase self-assembling cement-based material systems. This is achieved through three objectives. The first objective is to investigate resonant acoustic mixing, a mixing method not common to the concrete industry, and its ability to act as a high-intensive mixer. The second objective is to consider how using resonant acoustic mixing affects the assemblage of UHPC with carbon nanofiber inclusions and cement paste with carbon nanoplatelet inclusions. The third objective is to understand the origins of high-shear mixing and how it influences the development of cement hydration. To achieve these three objectives a systematic analysis is carried out that includes quantifying the mixing energy demand; analyzing surface characteristics through scanning electron microscopy, inverse gas chromatography, dynamic light scattering, and mercury intrusion porosity; and applying rheological theory to connect macroscopic properties to the fundamental properties of the materials. The results show that mixing is a very important parameter to multi-scale, multi-phase self-assembling cement-based materials and should be considered more in concrete research.