Tata Institute of Fundamental Research

Survey No. 36/P, Gopanpally Village, Serilingampally Mandal, Ranga Reddy Dist., Hyderabad – 500 046

Seminar

Application of multinuclear solid-state NMR to study sustainable cementitious materials

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Controlling greenhouse gas (GHG) emissions by human activities is a major challenge in combating global climate change. Cement industries are major CO_2 emitters, introducing 4 billion tons of CO_2 annually to the environment. Alkali-activated materials (AAM) are emerging as a sustainable alternative to Portland cement (PC) with reduced CO_2 emission. AAMs use industrial by-products such as ground granulated blast furnace slag (GGBS) and fly ash. The primary binding phase in the AAMs is the calcium aluminate silicate hydrate (C-A-S-H) gel, which has a layered tobermorite-like structure. The main intralayer of CaO is flanked by silicate chains on both sides, and it contains the chargebalancing alkali ions (Ca^{2+}, Na^{+}, etc.) and water molecules. The lengths of C-A-S-H chains and the local phases determine the strength and durability of these materials. Moreover, recent studies indicate that carbonating AAMs may enhance their cementitious properties. Hence, a precise structural characterization of AAMs is crucial for setting up rational design synthesis principles and understanding the mechanism of C-sequestration and its impact on the local structures of AAMs.

Solid-state NMR is a powerful technique to characterize such structurally heterogeneous systems. In this ongoing study, we investigate the molecular structure of two samples, i) GF- a GGBS, Fly Ash mix and ii) GFS- a GGBS, Fly Ash, and soil mix, in non-carbonated (NC) and carbonated (C) forms using ^{27}Al, ^{29}Si, ^{23}Na, and ^{1}H MAS NMR. The distribution of various local phases in the samples and their interconversion caused by carbonation will be discussed using direct, cross-polarization, and correlation solid-state NMR experiments. The results demonstrate how soil employment influences the microstructural changes in C-A-S-H on carbonation.

Monday, May 4th 2026

11:30 Hrs (Tea / Coffee 11:15 Hrs)

Auditorium, TIFRH