Functionalized, nanostructured multiscale cementitious materials

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The developement of sustainable multifunctional materials requires to move away from the linear economic model of take-make-use-dispose and to replace this with a higher efficiency and viability of using resources according to the “cradle to cradle principle“. A model for this can be nature. The transfer of structural principles from biological systems to new materials (bioinspired materials) with the help of nanotechnology is the key to develop such materials. The high strength, performance and durability of these materials alone is not sufficient. They should additionally bear other properties (functionalities) In addition, they should have “intelligent“ properties, multi-functionality, sustainability and economy. Hence it is imperative not only to have materials with the highest possible performance but also sustainable “intelligent“ ones with multi-functionality and cheap to produce.

Comprehensive basic research has been carried out using different methods of micro- and nanoanalytics on model systems in order to analyze the reaction mechanisms of the micro and nanoparticles. Self Compacting and Ultra High Performance Concrete with improved and new properties have been produced based on nanotechnology. On this basis, Ultra High Performance Concrete was also produced as a porous material by innovative foaming. The foam concretes can be used for heat and sound insulation. Multiscale Ultra High Performance Concrete (MSUHPC), a material on the front-edge of performance with extreme 2 hours strength (more than 400 MPa) was developed and its main properties characterized.

Alternative cement-free binders based on industrial by-products such as blastfurnace slag and fly ash have been developed to be used for the development of cement-free Self Compacting and Ultra High Performance Concrete. On top of that the the surface functionalisation of Ultra High Performance Concrete (MSUHPC) is carried with the aim is to develop multifunctional concrete that is not only very resilient, strong and durable but it has additional surface properties.

Keywords: functionalized, sustainable nanostructured cementitious materials, multiscale Ultra High Performance Concrete.