**Research aim**

The main aim of the presented project entitled: „Functional composites based on MULTIcomponent Portland cements modified with carbon-based nanomaterials: composition design, cHaracterizAtion of microStructure and propErties (MULTIPHASE)" is the fabrication of a new generation high-performance cementitious composites. We will develop completely new compositions of cement composites based on multicomponent Portland cements by incorporating carbon-based nanomaterials. The research will be focused on application of carbon-based nanomaterials in composite Portland-limestone and composite Portland-granulated blast furnace slag cements. Noteworthy, carbon-based nanomaterials will be graphene-related materials with excellent mechanical and electrical properties as well as environmentally-friendly and economical nanofillers, such as nanocellulose and/or nano biochar. The performance of cement composites will be improved via the fine tuning of carbon-based nanomaterials' morphology and composition as well as by tailoring their dispersion and the fabrication method of cement composites. Moreover, MULTIPHASE aims also to gain a detailed understanding on the effect of carbon-based nanomaterials on hydration mechanisms and properties of Portland-limestone and Portland-granulated blast furnace slag cement composites.

**Research methodology**

First, we will synthesize and/or functionalize carbon-based nanomaterials that will allow the improvement of the hydration of multicomponent Portland cements as well as the enhancement of the microstructure of their composites. We will then develop the efficient and technologically simple method for the dispersion of carbon-based nanomaterials in cement matrix and we will design the composition and protocol for fabrication of cement composites. Within the second stage of the project, we will evaluate the effects of carbon-based nanomaterials on the hydration mechanisms and microstructure development of multicomponent Portland cement composites. To this aim, hydration kinetics studies as well as complex microstructural characterization of cement pastes after different time of hydration will be performed. Finally, we will investigate the effects of carbon-based nanomaterials on basic properties of multicomponent Portland cement composites, such as mechanical properties and durability-related properties (adsorption, chloride migration, carbonation and freeze-thaw tests). Additionally, the potential formation of carbon-based nanomaterials' conductive paths within the matrix of multicomponent Portland cement composites and the improvement of their self-sensing ability will be also investigated.

**Research impact**

The composites designed and fabricated within MULTIPHASE will feature enhanced microstructure, mechanical properties, durability and/or self-sensing ability. Even though the effect of various carbon-based nanomaterials on microstructure and properties of cementitious composites has been extensively studied up to date, most of the research conducted within this field is based on the use of Ordinary Portland Cement CEM I. The research conducted within the project will allow us to gain a deep understanding of the effect of carbon-based nanomaterials on the hydration reactions of multicomponent Portland cements being the most commonly applied cements in concrete technology nowadays. This will open up new avenues for the technological applications of carbon-based nanomaterials in civil engineering towards safe and environmentally friendly concrete structures.