POPULAR SUMMARY OF THE PROJECT

Title: ***Design of cement composites doped with functional nano- and micromaterials with photocatalytic and antimicrobial properties***

Due to the growing number of requirements concerning the durability and quality of building materials in the past few years, the construction industry has been increasingly turning to new technologies, mainly towards nanotechnology. The most commonly used solution today is the modification of the microstructure of cement composites with inorganic nano- and micromaterials. However, despite this trend, the proper design of new methods of obtaining and sequentially introducing nano- and microadditives into the cement matrix is becoming increasingly important as a key aspect which guarantees their effective operation. This is one of the major challenges currently facing scientists enabling further development in the such fields of science as material engineering, technical chemistry and related environmental engineering.

The proposed project is based on the hypothesis that despite the wide range of materials and/or biomaterials available for various technological applications, there seems a clear need for novel and specially designed hybrid materials with defined, strictly controlled properties. These would then be used as functional admixtures/additives in the production of active cement composites for application in modern and sustainable construction. This aspect of the design can be considered completely innovative.

The primary goal of the submitted project is the design of functional inorganic-organic hybrid materials formed using selected oxides, multi-component oxides or silicate oxide systems and biopolymers (lignin and/or its derivatives) as admixtures in cement composites. Within the framework of the project, it will be vital to carefully consider the type and amount of cement binder, the composition of the aggregate and the water-cement ratio enabling the selective operation of newly developed, advanced admixtures.

Due to ever worsening environmental pollution, an important goal will be to determine the self-cleaning properties of the obtained mortars, which will mainly result from the presence of nanocrystalline TiO_2 in their structure, enabling the occurrence of photocatalytic processes and affecting the light-induced superhydrophilicity of the surface. Verifying the ability of the obtained composites, which include appropriate admixtures, to inhibit the growth of selected model species of microorganisms (Gram-positive and Gram-negative bacteria, and fungi), algae and mosses will be an extension of these tests

Furthermore, determining the impact of the structural parameters of the obtained nanoadditives will be a significant element of this stage of the research. The application of the obtained systems will mainly contribute to an improvement in the compaction and lower porosity of the cement binder structure as well as an improvement in adhesion at the cement paste-aggregate interface, which in turn will enhance the mechanical (mainly by the addition of nanosilica), self-cleaning and self-disinfecting (mainly using titanium dioxide, zinc oxide) properties of the cement composites, depending on the additive used. The performance of aging tests to determine the resistance of the materials to long-term environmental conditions will be a crucial element in the project's realization.

The research topic proposed in the project is a response to the current problems associated with the use of admixtures/additives in cement composites, primarily with the problem of their effective dispersion in the cement matrix. The positive results obtained in the project will certainly contribute to the development of nanotechnology in terms of sustainable construction, mainly in the field of basic research. This will consequently make it possible to obtain advanced but relatively cheap and reproducible products in terms of their physicochemical and dispersion-microstructural properties. A measurable result of the project includes conducting interdisciplinary research, the results of which will contribute to a significant extension of the knowledge in this scientific area, and the development of related disciplines, as well as high-impact publications, indexed by Thomson Reuters JCR.