Recently, considerable attention has been paid to the use of self-assembly process in generation of functional nanostructures of fascinating physicochemical properties, thanks to which they found applications in controlled modulation of small molecule reactivity and transport. Particularly attractive are nanostructures with a 3D structure, which thanks to the presence of 'free' internal cavity (pores) that may 'catch' different molecules of interest, for example: explosive materials, drugs, catalysts or green gases.

In the proposed project the new generation of dynamic 3D nanocapsules will be designed and synthesized. The multimembered nanostructures will be obtained from simple molecules – 'bricks' which will self-assemble in the form of the capsule by weak, non-covalent interactions. The physicochemical properties of these capsules will be investigated by various of analytical techniques. The next aspect of the proposed project will concern the controlled changes of structural properties (i.e. size and shape) of the nanocapsule and impact of these changes on their functionality and applications. This will lead to the formation of the entirely new family of dynamic 3D nanoobjects of sophisticated complexing/binding properties, that can be reversibly altered by using external stimuli (both physical and chemical), for example: temperature, solvent, light etc. Such dynamic structures can be potentially be used as nanotransporters whose size and complexing properties can be reversibly modified, thereby significantly increasing the applicability of such systems in molecular transport. In addition, the proposed project assumes carrying out research on controlled deactivation of toxic and explosive substances. For this reason, the synthesis and study of basic structural, physico-chemical and complexing properties of the obtained nanocapsules will also be directed towards their potential application in the development of new adaptive materials for industrial applications, e.g. greenhouse gas storage. Most of the currently available studies in the field of nanotechnology describing the structure of nanoarchitectures uses top-down strategy, involving the miniaturization of currently known larger objects and materials. The proposed project focuses on the reverse strategy: bottom-up approach, that is, the construction of nanostructures starting from appropriately small building blocks, which ultimately give dynamic systems with specific properties. The strategic impact of the presented research project includes the development of a new series of dynamic 3D bioreceptors with adaptive properties.

The presented research project is very interdisciplinary in character and covers many chemical fields, including organic chemistry, physical organic chemistry or combinatorial chemistry, which have been identified under the common umbrella of supramolecular chemistry. The results obtained during the research will have a wide impact in the scientific community in Poland and abroad due to the receipt of multi-functional nanostructures with application potential in the chemical, but also biological or energy sector.