Carbon allotropes have been very interesting subject for scientific community. Therefore, the one of the major subjects of this project is the synthesis and study of the properties of Multi Walled Carbon Nanohorns - MWCNH (obtained for the first time in this project a new carbon allotrope) and the optimization of the synthesis process. The next important subject of this project is the creation of novel hydrophobic and superomniphobic surfaces composed of MWCNH, Single Walled Carbon Nanohorns (SWCNH), Carbon NanoOnions (CNO) and hydrothermal Carbon nanoSpheres (CS). A gap occurs in the field of the application of recently discovered carbon nanomaterials for the creation of hydrophobic, superhydrophobic and especially superomniphobic surfaces. On the other hand, there is a need of this kind of surfaces application. They are applied, for example, for the covering of the screens (and/or surfaces) of mobile devices, for the creation of self-cleaning non-fouling surfaces, for stain-free clothing and spill-resistant protective wear and drag reduction. Moreover, they can be applied for the preparation of devices floating on high and low surface tension liquids. Simultaneously they can carry large weights. Thus, they are good candidates for the construction of nano- microrobots applied (for example) in military marine operations, and/or as nano-microrobots sensing in aqueous environment. They can also self-propel by a Marangoni flow. We are sure that MWCNH (a new carbon allotrope), SWCNH, CNO and CS are perfect candidates for the creation of hydrophobic, superhydrophobic and superomniphobic surfaces.

The surfaces will be created from nanomaterials alone as well as from the mixtures. Carbon, especially carbon nanohorns, are perfect candidates for the creation of such a kind of surfaces because they possess high mechanical resistivity, natural hydrophobicity, and the possibility of hierarchical textures creation. All these properties of carbon nanomaterials lead to the minimization of a droplet surface contact area and the work of adhesion. This finally leads to the large contact angle values.

Proposed in this project for the first time synthesis of a new carbon allotrope (MWCNH nanoparticles) is based on the modified (unpublished) procedure similar to this proposed for SWCNH synthesis by Sano. However, in our case instead of SWCNH the creation of MWCNH is observed (our method is a modification of an arc-in-a-liquid procedure). In this project we will also study commercially available SWCNH, CNO - obtained for the purpose of this project (also using an arc method), and hydrothermally obtained CS. Using this series of nanomaterials the surfaces possessing hierarchical structures will be created. Recent literature studies prove that this type of structure strongly supports the appearance of highly hydrophobic and superomniphobic properties. The hierarchical structures will be obtained by: a recently published by Oakes et al. electrophoretic deposition method on polyethylene (PE), polymethyl methacrylate (PMMA), polystyrene (PS) and carbon fibres (CF). Before deposition the surfaces will be subjected to modification using a cold plasma. For the comparative purposes the composites with no plasma modified PS and PMMA will be also created (in this case the surfaces of polymers-containing composites will be dissolved/scratched to get a better availability to carbon nanomaterials). Contact and sliding angles for a series of liquids (having various surface tension values) will be measured to get information about hydrophobicity of surfaces. Next, to induce the superomniphobic properties, selected hierarchical nanomaterials will be chemically modified using fluorinated monoalkylphosphates (FMAP), (tridecafluoro-1,1,2,2-tetrahydrooctyl)trichlorosilane (FTCS), perfluorodecyltrichlorosilane (PFDTS) and perfluorooctyl acid (PFOA). Molecular simulations will be additionally performed to propose a MWCNH model, to get deeper insight into a wetting process, to determine the nanometric contact angles and to discover the nature of the processes.

PI expects that the discovery of a new carbon allotrope - MWCNH (confirmed by our preliminary results) will give a high impact on the development of carbon nanomaterials science. PI also expects that the MWCNH properties will be different than these observed for SWCNH. This can be similar difference as it is observed between the properties of single and multiwalled carbon nanotubes. Finally, PI hopes that novel superhydrophobic and superomniphobic surfaces will find applications in the branches mentioned above.