One of the most important tasks of modern society is to solve the problem of cancer. Despite the widespread use of chemotherapy, more and more frequent reports of its lack of efficacy have been reported. This project will contribute to the development of alternative to chemotherapy methods for cancer treatment and nanomedicine, involving materials of two-dimensional structure (2D). In this area, MXenes phases are interesting due to their unique physico-chemical properties and structure. The breakthrough can be a reduction of their lateral size and the formation of 2D nano-crystals.

Properties of 2D materials differ dramatically from their 3D analogs. Graphene and its three-dimensional analog graphite is one of the better examples. Graphene as a 2D structure is a very good conductor of heat and electricity, transparent, characterized by very high mobility of electrons. These properties are significantly different from its 3D equivalent - graphite, soft opaque mineral, splintery and susceptible to abrasion. This difference in the properties of 2D and 3D structures results in a search of new methods of transformation of the known layered three-dimensional structures to the two-dimensional structures with unique properties. Since many years, the MAX phases of the $M_{n+1}AX_n$ composition have been known as 3D structures with alternately stacked layers of metals and metalloids. Our initial studies confirmed by the literature data revealed the possibility of expanding of MAX phases to MXenes by removing one layer of the element from the crystal structure. In addition, using liquid sonication we are able to exfoliate MXenes to 2D structures of light transition metals carbides.

The main scientific and cognitive aim of the project is to investigate *in vitro* anticancer and cytotoxic properties of the new family of 2D nano-crystals - titanium carbides and nitrides (MXene phases, such as Ti_2C, Ti_3C_2, Ti_2N, Ti_4N_3) as well as their influence on cells in the aspect of *(A) specific interactions of the physico-chemical nature between 2D nano-crystal and cell surface and/or its interior, (B) cell function – molecular mechanisms of interactions on the level of receptors, proteins and genes*. The Project objective is also to create the new research team and its development as a result of realization of the Project, on the basis of combination of experimental investigations with computer simulations.

The two-dimensional nano-structures of titanium carbides and nitrides will be investigated in the project, which will be characterized with different stoichiometry (Ti_2C, Ti_3C_2, Ti_2N or Ti_4N_3). They were selected from the very numerous group of the MXenes phases as promising in context of searching for potential anticancer drugs. The planned basic *in vitro* studies of the interactions of MXene 2D nano-crystals towards cancerous and normal cells will enable gaining essential information on the influence of their properties on the observed mechanisms. Numerical methods will be valuable supplement to experimental studies, reducing the number of tests i.e. time and costs of research and will ensure support to the final verification of assumed research hypothesis.