Nanomaterials exhibit a number of specific properties which differ them from conventional microcrystalline counterparts. As an example, in bulk solids, melting temperature is considered as a constant, specific for each material. However, the melting temperature decreases for very small sizes of melted elements, This phenomenon is called melting point depression (MPD) and was theoretically predicted and experimentally proven for many nanoscale materials, mainly freestanding nanoparticles of single elements with a relatively low melting temperature. The overall objective of the project is to give an insight into fundamental understanding and mechanism of the melting behaviour of nanomultilayer structure consisting alternatively deposited nanolayers of an eutectic metallic alloy or pure metal (with relatively low melting temperature) and ceramic interlayer with high melting temperature. Such a system is very interesting from scientific point of view because the number of microstructural factors affecting their melting behaviour is rather large and include: layers' thickness, coherency of interface (metal-ceramic) boundary, grain size of metallic layer as well as its phase composition. Currently, it is known that layer's thickness strongly influences the melting behaviour, i.e. the smaller thickness the more pronounced melting point depression. Therefore, the hypothesis was set that melting point depression in nanomultilayer systems depends not only on their thickness but also on the grain size, phase composition of metallic nanolayers as well as the interface between metallic and ceramic phase and its characteristics.

In order to prove the thesis proposed, the samples of various microstructures will be produced by magnetron sputtering. The samples will differ in layer's thickness, chemical composition of metallic layer (either pure metal or eutectic composition), grain size of metallic layer. Next, the samples will be characterized in terms of actual layer thickness, interface (metal-ceramic) boundary, grain size and phase composition. After that melting process will be analyzed in various systems. Possible phase transformations in metallic layers will determined by high temperature X-ray diffraction and transmission electron microscopy. Melting process and determination of melting temperature will be studied by calorymetry and SEM observations of nanomultilayers' surface after heating at various temperature. Structural changes in nanomultilayers' systems after heating above melting temperature will also be tested by transmission electron microscopy. Experimental studies will be supported by molecular dynamic simulations aiming at determining the role of various microstructural elements on melting behavior of nanomultilayers.

The proposed project is of high importance for the development of the scientific field which is materials engineering. Understanding basic phenomena responsible for melting point depression in complex materials systems such as nanomultilayers will enable to design an optimum system e.g. for low temperature joining. Modern joining technology requires reliable joining processes at low temperature which will enable heat sensitive materials, e.g. nanomaterials, to be joined without losing their properties governed by the nanoscale structure. On the other hand, the general requirement in the context of societal challenges is low temperature technologies which are cost effective, reduces energy consumption and thus environmental pollution. In addition, the project will contribute to the creation of new knowledge about the impact of the microstructure, including the character of grain boundaries and interfaces, on the melting point depression of nanomaterials in the form of nanomultilayers.