The polymer nanocomposites are new class of material, with enhanced properties due to distribution of very small particles (size of 10^{-7} to 10^{-9} m) inside the polymer matrix. Wide range of properties can be improved: strength, toughness, flexibility, wear, insulation for mega-voltage, electrical conductivity, gas barrier properties, fire retardancy, scratch resistance, etc. Nanoparticles would have shape of nanofibers, nanotubes (e.g. carbon), nanorodes, nanoplates (e.g. graphene, clay minerals) and nanograins (e.g. metal oxides). Usually the surface of nanofillers is modified in order to maintain a good adhesion between polymer and nanofillers which is necessary for obtaining and preserving the improved properties of a nanocomposite.

Any larger deformation, such as accidental or intended stretching or bending, may cause the loss of contact between nanoparticles and the polymer matrix and formation nanocavities (nanovoids) around nanoparticles. This effect leads to a loss of desired properties.

The knowledge about how the cavities are formed is currently limited to a bare observation that cavities are mostly initiated around nanofiller particles. This project is devoted to finding the rules that govern cavitation initiation and development. The evolution of cavities with increasing force is also of interest and will be explored. The studies will go more deeply in investigation how serious can be the damage to the structure and properties caused by cavitation and what are the physical reasons of cavitation in nanocomposites. It will be searched how differently nanograins, nanofibers and nanoplates initiate cavitation. Any physical factors that may affect cavitation such as wetting of nanofillers by a polymer, thermal shrinkage, shrinkage during solidification and pressure that is induced by interfacial tension will be elucidated. While acquiring that knowledge we will seek the means of preventing cavitation or dampen it by increasing the force needed for its initiation.

Polymers for the studies will be selected from commodity polymers including biodegradable and from renewable resources. Nanoparticles will be selected from the group of various carbon nanotubes, graphenes, clays and oxides and their surfaces will be modified for improving contacts. Many experimental methods will be used for detection of cavities and for following their development including: x-ray diffraction and scattering, electron microscopy, various types of spectrometry, mechanical tests, gas permeability. Cavities have natural tendency to heal when strain or stress are released hence, there is a need to in-situ experimentation.

Cavitation cannot be totally undesirable. Polymer nanocomposites are now used in many demanding applications, in which voids may play negative or positive role. The results of the project will lead to an understanding of requirements for cavitation. Based on that knowledge it will be demonstrated how to prevent cavitation (for applications: electrical insulation, high strength, barrier or transparent nanocomposites) but also how to escalate cavitation (for sensors of unwanted excessive strains or stresses or for making nanofoams).