It is a fact that tissue engineering is dynamically evolving research area, whether we think of a cellular stimulation methods, novel multifunctional materials or cutting edge technologies. The trend toward biomimetism has been observed for years, making electrospinning, though not a new idea itself, a technique that has still a lot of to offer, considering a remarkable structural similarity of electrospun materials to extracellular matrix.

Materials made of polycaprolactone have been present in scientific literature focusing on scaffolds for tissue engineering, for a couple of years now. Polycaprolactone belongs to a group of biodegradable aliphatic polyesters, has good mechanical properties and is not cytotoxic. In comparison to other materials from this group it has lower stiffness (lower Young's modulus) and its degradation products does not cause a decrease in pH in an area surrounding a graft, what has been reported for polylactide or polyglicolide and may increase inflammation.
As any other aliphatic polyester, polycaprolactone is hydrophobic, what is a disadvantage for materials used in scaffolds. This problem can be solved by an addition of highly hydrophilic substance, in this case gelatin, not only allows to significantly decrease hydrophobicity, but gelatin, being a biopolymer derived from collagen, the major extracellular matrix building protein, has also a favourable influence on cellular response of a material.

The Polymer Physics Laboratory IPPT PAN has optimized the process of electrospinning of PCL/gelatin nanofibers based on the use of non-toxic, alternative solvents. The disadvantage of this solvent system is the fact that polymer solution becomes visibly emulsive, which is not observed in solutions from commonly used solvents. The consequence of this situation is non-uniform distribution of gelatin in the fibre structure.

The research which has been planned for this project aims to solve a serious problem occurring in this material system, which is the loss of biopolymer (gelatin) in an environment of a living organism. The solution to this problem, proposed in this research project, is crosslinking of PCL/gelatin materials. It prevents the bicomponent nonwovens from the loss of properties that are beneficial for cell activity. What is more, cross-linking of the gelatin will help avoid decreasing the mechanical properties associated with weight loss and weakening of the fiber structure caused by linear groove-like sites remaining after gelatin leaching.

The main objective of the project is to determine the optimal method of crosslinking of the polycaprolactone nanofibers with the addition of gelatin electrospun from alternative solvents for use of this type of biomaterials in tissue engineering.
The first part of this project is the formation of bicomponent polycaprolactone/gelatin nanofibrous materials by electrospinning, both of the alternative solvents and commonly used. The next step will be the selection of one crosslinking agent from the group of the proposed four that are low toxic and have a high innovative potential. PCL/gelatin nonwovens will undergo crosslinking with each of the four compounds, using only a minimum range of process conditions. The selected compound will be used for systematic crosslinking of materials obtained in the first step of the research. Various conditions of crosslinking (concentration/time) are planned. Thus prepared materials will undergo a series of tests to assess the effect of crosslinking conditions on the structure and properties of investigated bicomponent nanofibers. Additionally biodegradation tests will be performed, where samples will be placed in PBS in 37°C for a different periods of time, which will provide us with the information about gelatin leaching kinetics depending on the crosslinking conditions about the influence of crosslinking. The last step includes in-vitro studies involving cells. There will be cytotoxicity tests performed. Together with cell culture experiments in direct contact with the materials and DNA tests, they will help determine which materials are most favorable in regard of cell adhesion, spreading and proliferation.

Expected results of the experiments scheduled in the project are intended to provide medicine with new type of scaffold material whose functionality exceeds any of the currently available on the market.