"Electrospinning of short fibers for composite reinforcement"

Due to the exponential growth of technology, demand for the design of new composite materials continues to grow. However, due to limited reinforcement methods, productions and cost, they still require many improvements.

Composite material is defined as combining two or more materials, where one of them plays the role of matrix and the other a reinforcing phase. Due to the structure of reinforcement, they are divided into particle and fiber-reinforced composites. The most promising of these are nano- and micro-size short fibers, which significantly improve the material's performance without substantial interference with the structure. However, the magnitude of this effect depends primarily on the length to diameter ratio, mechanical and surface properties of a single fiber.

Conventional, short fibers are produced by mechanical cutting of fibrous polymer meshes. As a result, short fibers with a broad distribution in length and additional stresses induced in the material by cutting are obtained, which is the biggest drawback. Direct production of regular short fibers is one of the solutions to this problem.

Electrospinning is a standard method used to produce continuous polymer fibers with a diameter ranging from nano- to micrometers. Furthermore, fiber surface and bulk properties can be tailored during the electrospinning by changing electric field strength, i.e., by applied voltage or electrical polarity. Notably, there are studies where short polymeric fibers are obtained directly by electrospinning, choosing appropriate process and polymer solution parameters.

The project aims to produce short fibers using the electrospinning method and implement them in the composite structure. The research will focus on determining the effect of process parameters on the ability to produce short fibers. Then, the mechanical properties of individual fibers produced by electrospinning will be determined and compared to fibers produced by mechanical cutting, using advanced techniques such as electron and atomic force microscopy. In the final phase, the mechanical properties of the composite materials reinforced with short polymer fibers will be investigated.

The proposed project's general objective is to develop short fibers directly via electrospinning to create high-performance fiber-reinforced composites for application in space industry and biotechnology.