

Partial loss of human tissue is connected to loss of everyday bodily functions – from esthetical problems to drastic changes in life quality, such as permanent paralysis or maiming. Even though living organisms have a regenerative capability, many tissues can only be subjected to small damage until permanent loss of function happens.

Modern regenerative medicine and its subdivision of tissue engineering, stemming from the connection of medicine and material and biomedical engineering aims to solve this problem through the manufacturing of scaffolds, imitating the natural microenvironment of human and animal cells – the extracellular matrix. The extracellular matrix mainly consists of collagen fibers of diameters in the microscale, allowing for the adhesion and proliferation of cells and the exchange of nutrients and metabolites.

Tissue engineering is involved in the creation of artificial extracellular matrices that, when implanted in the body, can allow tissue regeneration far beyond its natural capabilities. This project is based on the author's previous experience of creating scaffolds of polymeric materials that break down into simple compounds in the human body and are excreted without accumulation or harm to the body. The diameters of these fibers are in the range of tenths of parts to one micrometer, and their structure cleverly imitates the mechanical properties (stiffness, strength, elasticity) of the natural extracellular matrix.

The natural environment of cells is also characterized by electrical conductivity, allowing communication between cells. Therefore, the idea according to the design is based on the production of composite materials, and thus combining the properties of at least two materials together with properties that go beyond the separate components of their parts. Modern material, graphene, in the form of reduced graphene oxide powder, with unparalleled mechanical properties, high thermal and electrical conductivity and potentially safe in the human body environment will be used as an additive to improve polymer fibers. The fibers together with the addition of graphene will be made using a modern method similar to spinning spider webs or using spray paint. The fibers will be blown out in the gas stream, which allows high mobility of the method, which could even be used as a device for the portable manufacture of dressings for accident victims or patients in hospitals.

The applied method is the blowing of a polymer solution, and its use for the production of fibrous composites of graphene is completely novel. In vitro cell research and numerous microscopic studies will be carried out to determine the spatial distribution of the reduced graphene oxide flakes, its combination with the polymer, the effect of manufacturing process parameters and the nanoplatelet content on cell interactions and mechanical properties of the material.