Hydrogels can be considered as three-dimensional, hydrophilic networks of flexible polymer chains swollen by water or other fluid. They are able to hold a large amount of water (even up to thousands of times their dry weight) while maintaining the structure that can be cast into practically any shape or form. They are soft and capable of retaining large amounts of water thus closely resemble living tissues. Mainly for that reason hydrogels are considered particularly promising materials in the rapidly growing field of tissue engineering as matrices for replacing and regenerating different tissues and organs. The use of biocompatible hydrogels in tissue engineering is constantly increasing. The main reason for this is, perhaps, the fact that those scaffolds provide the necessary temporary template for the growth of the target tissues. The need for regenerative medicine stems from the limited availability of autologous tissue and the potential for immune rejection of allogeneic sources, with the consequent practical limitation of organ transplantation. Future development of regenerative medicine heavily depends on the availability of adequate biomaterials. In this context thorough knowledge about novel hydrogel-based biomaterials that combine the required physical and chemical properties needed for regenerative medicine that will be developed during this project can finally contribute to a broader and even more efficient implementation of the regenerative medicine.

The main objective of the project is to design and fabricate a novel advanced magnetic hydrogels composed of biocompatible natural polymers and nano- to micro-sized functionalized magnetic particles with different chemistries and morphologies. Thanks to the presence of magnetic particles the biomechanical properties of the fabricated ferrogels will controllable by means of noncontact magnetic forces taking advantage of magnetorheological effect. It is worth to emphasize that nano-/micron-sized magnetic particles will not be only physically dispersed into hydrogel network but rather “forced” to form chemical bonds with polymeric chains and will serve as nodes inflecting the final properties of ferrogels. Such ingenious approach will result in advanced magnetic hydrogels with attractive properties, such as tunable porosity, structural anisotropy and tailorable rheological and actuating properties. As a result the resulting hydrogels will possess significantly better performance towards the targeted application while keeping their high biocompatibility and superior cell binding properties. In addition, fabricated ferrogels will be composed of cheap and abundant materials, which will further expand the scope of their potential applications.