Project title: **Fine-tuning of polyelectrolyte complexes properties via ternary composition**

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Polyelectrolyte complexes are formed as a result of phase separation when two solutions of oppositely charged polyelectrolytes are mixed. Two phases are formed: a dilute phase and a polymer-rich phase, containing polyelectrolyte complexes. Complex formation is driven by electrostatic attraction between oppositely charged polyelectrolytes as well as entropic effects associated with the release of counterions and water molecules into the solution. Depending on the composition and synthesis conditions, polyelectrolyte complexes may be in the form of solid complexes or liquid-like coacervates.

Solid complexes can be used to form polymeric materials whose properties strongly depend on the synthesis conditions, such as pH, electrolyte type and concentration, solvent type, and chemical composition. Due to their tunability and versatility materials based on polyelectrolyte complexes are widely used in the field of drug delivery, tissue engineering, electrochemistry, production of separation membranes, contact adhesives, and many others.

So far, in the literature, mainly binary polyelectrolyte complexes have been studied, i.e. composed of one positively charged and one negatively charged polyelectrolyte. However, changing one of the polyelectrolytes results in a significant, abrupt change in the properties of the produced material, which limits the possibilities of its control. To enable better tuning of the properties of these materials, this project aims at conducting extensive theoretical and experimental research on the preparation of ternary polyelectrolyte complexes, which will determine the relationship between the stoichiometry and macroscopic properties of the produced materials.

In the first stage of the project, all-atom molecular dynamics modeling and experimental techniques, based on light scattering, will be utilized. The research will provide information about the form and the properties of polyelectrolyte complexes depending on their composition and enable to determine a phase diagrams of ternary polyelectrolyte mixtures.

The second stage will focus on the production and characterization of polymer materials based on ternary polyelectrolyte complexes. The research aims at determining changes in the mechanical and thermal properties of the produced materials related to the different composition of the complex. Additionally, theoretical modeling will allow us to understand the mechanism of these changes at molecular level and will serve as an extremely useful predictive tool.

The above research, combining theoretical modeling and experimental research, will allow predicting the properties of materials based on ternary polyelectrolyte complexes and controlling them in a continuous manner. The project will be conducted in international collaboration (Texas A&M, University, USA) with a leading group in the field of synthesis of polymer materials. The obtained results will also allow for a better understanding of these extremely interesting and promising materials.