New polymersomes formed by a pair of strong block polyelectrolytes – properties and application as carriers of substances

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Polymersomes are vesicular structures formed by a self-assembly process of appropriate block copolymers. These copolymers show the ability to self-organize into sheets or lamella in aqueous media, which close to form the vesicles under appropriate conditions. However, the methods for preparing polymersomes from block copolymers are relatively complicated, time-consuming and require the use of organic solvents. The main goal of the proposed project is to study of the properties of a new class of polymersomes. These polymersomes will be obtained from a pair of copolymers that will spontaneously form vesicles in aqueous solution, due to the electrostatic interactions between polyanionic and polycationic parts of the applied compounds. Figure 1 shows schematically idea of formation of the new class of polymersomes.

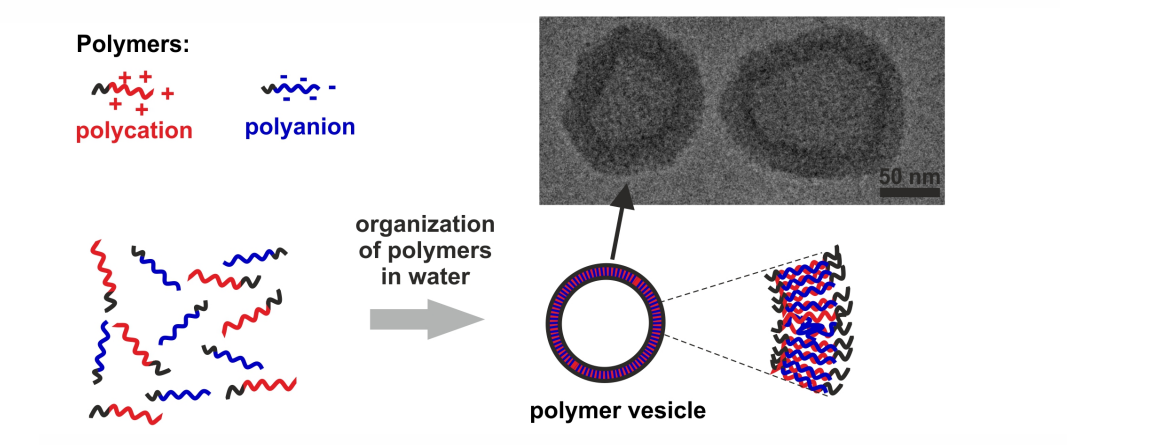

Fig. 1. Schematic illustration of the organization of oppositely charged polymers in aqueous solution with formation of polymersomes. In the upper right corner a picture of the polymersomes made by electron microscopy is shown.

Our research will focus on the possibility of applying these polymer vesicles as carriers of drugs and bioactive substances. For this purpose, we plan to explore stability of the obtained vesicles, their biocompatibility and ability to enclose model substances with different properties in the polymersomes.

Studies on the stability of polymersomes are very important to determine the conditions under which the vesicles keep their integrity or are disintegrated. Within this task, the impact of the salt concentration, pH, temperature and presence of serum on the stability of vesicles will be investigated. This allows one to determine what conditions are optimal to use such polymersomes.

Biocompatibility is a crucial parameter for structures that are considered as a potential drug carriers. For this reason, our vesicles and both polymers will be tested for their effect on normal cells (e. g. human skin fibroblasts).

Study on the accumulation of model substances in polymersomes is a main part of this project. Some fluorescent dyes with different properties will be used as the model substances. Moreover, one of commercially-available drugs also will be tested. The use of various compounds will allow us to assess the possibility of encapsulation of substances in the membrane or in the aqueous interior of the polymersome. Methods based on the fluorescent properties of the model substances will be used to observe the encapsulation of the dyes in polymer vesicles or their leakage from them induced by the change of various factors (salt concentration, pH, temperature, etc.). Figure 2 schematically shows the encapsulation of the substances with different properties in the polymersomes and their release triggered by external factors.

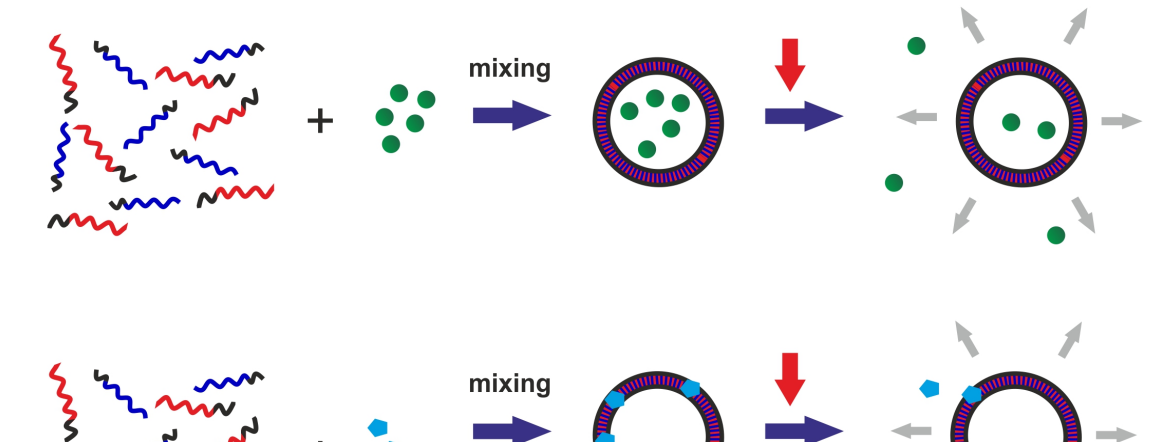

Fig. 2. Schematic illustration of the encapsulation of substances with different properties (shown as green circles and blue pentagons) in vesicles and leakage of them due to the change of crucial factors like pH, salt concentration, temperature, etc. (indicated by red arrows).

The results of our project will be significant for the development of the new type of polymersomes. Experiments performed during the project will contribute to increase knowledge about the properties of new polymersomes and their interactions with various model substances. The results of these studies will be useful for developing new carriers of substances that may be of potential application in nanotechnology and biomedicine.