Biomimetic polypeptide and polysaccharide based polymersomes for therapy and diagnosis

Sébastien Lecommandoux

Université de Bordeaux, IPB-ENSCBP, 16 avenue Pey Berland, 33607 Pessac Cedex, France, CNRS, Laboratoire de Chimie des Polymères Organiques, UMR5629, Pessac, France

lecommandoux@enscbp.fr

Polymer vesicles (polymersomes) are among the most attractive systems for drug delivery applications. Actually, vesicles obtained by self-assembly of block copolymers are expected to overcome some of the current limitations in drug delivery, allowing the development of robust nanocontainers of either hydrophilic or hydrophobic species. In addition, the development of macromolecular nanodevices that can be used within the living body implies that sensors detecting chemical signals -such as ions, enzymes or pH changes- and generating internal signals or appropriate responses be integrated in the macromolecular system [1]. The use of peptide and saccharide building blocks in the copolymer structure would allow both controlling the self-assembled structure and the resultant biofunctionality.

We report an overview on the self-assembly in water of amphiphilic block copolymers into polymersomes, and their applications in loading and controlled release of both hydrophilic and hydrophobic molecules and biomolecules. We pay special attention to polysaccharide and polypeptide-based block copolymer vesicles that we have studied these recent years in our group [2,3]. These newly developed copolymers that mimic the structure and function of glycoproteins represent an example of the effectiveness of a biomimetic strategy in implementing materials design [4]. In addition, magnetic polymersomes, including iron oxide γ-Fe_2O_3 nanoparticles are currently investigated, together with their potential applications as contrast agent for imaging and as therapeutic nanoparticles using hyperthermia [5]. Exciting and very promising results about their therapeutic evaluation for tumor targeting and in vivo tumor regression studies will be presented [6].

Finally our recent advances in using “biomimicry approaches” to design complex, compartmentalized materials will be proposed [7]. We demonstrate the formation of compartmentalized polymersomes with an internal « gelly » cavity using an original and versatile emulsion-centrifugation process. Such a system constitutes a first step towards the challenge of structural cell mimicry with both “organelles” and “cytoplasm mimics”. This study constitutes major progress in the field of structural biomimicry and will certainly enable the rise of new, highly interesting properties in the field of high-added value soft matter, especially in controlled cascade (bio)reactions.

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