Nanocomposite membraneous vesicles for controlled encapsulation, transport and release

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Functional nano-engineered materials formed by natural or biocompatible components are necessary for bio-medicine and other important fields of science and engineering [1]. We present results of design, preparation and characterization of new nanocomposite biocompatible membraneous vesicles based on the interfacial polycrystals of biogenic lipid phosphatidylcholine, synthetic amphiphilic polyanine stearoylspermine, polyelectrolytes and functional inorganic nanoparticles (magnetic iron oxide nanoparticles and metallic Au nanoparticles with mean diameter less than 10 nm). Amphiphilic water-insoluble polyanine stearoylspermine was synthesized and characterized by FTIR and NMR spectroscopy techniques.

Nanocomposite membraneous vesicles were prepared successfully by adsorption of colloid magnetite and gold nanoparticles onto the membrane surface of hybrid phosphatidylcholine/stearoylspermine liposomes with diameter 100-200 nm preliminarily formed using conventional ultrasound method. The obtained nanocomposite vesicles were characterized by transmission electron microscopy, AFM, electron magnetic resonance technique, laser light scattering and electrophoresis techniques.

The study of the effects of ultrashort high strength electromagnetic pulses and of applied external magnetic field on those vesicles have been carried out and the non-thermal decapsulation effect and efficient release of capsulated model compound was observed. TEM and AFM data showed that the structure of vesicles was changed substantially by those external physical factors. It was experimentally demonstrated and theoretically proved that the presence of conducting nanoparticles in the vesicle membrane can decrease substantially the voltage of applied electric pulses resulting in the substantial membrane structural changes and efficient vesicle “opening” [2]. It was found that additional polyelectrolyte complex layers formed on the surface of nanocomposite vesicles can change substantially the physical-chemical characteristics of such vesicles and their stability and resistivity against external stimulating physical factors as electromagnetic fields.

The data obtained give evidence that the synthesized stable biocompatible nanocomposite magnetic membraneous vesicles can be prospective for development of novel efficient means for encapsulation, controlled spatial localization, remote non-thermal release of various compounds in aqueous media for biomedical controlled drug delivery and other applications.

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