Layer-by-layer approach as a tool for enhanced functionality: Surface engineering of vesicular-type nanocarriers co-loaded with persistent luminescence nanoparticles and photosensitizers

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One of the possible approaches for organic-to-water phase transfer of luminescence nanoparticles (NPs), with potential biomedical applications, is to encapsulate them in L-α-phosphatidylcholine-based nanocarriers, stabilized with selected mild surfactant, cocamidopropyl betaine (NCR-NPs). Such colloidal NCR-NPs can be distinguished by high stability and loading capacity, as well as their ability to effectively sustain the NPs emission while transferring hydrophobic cargo to an aqueous environment. Additionally, co-encapsulation of NPs with selected second-generation photosensitizers (e.g., chlorin e6) can enhance the nanoplatform application properties, e.g., in photodynamic therapy (PDT). Though, if these NCR-NPs are intended for *in vivo* applications, additional surface functionalization to achieve specificity towards selected cells is needed. For such enhanced functionality, the layer-by-layer (LbL) approach seems like a reasonable solution. LbL serves as a bottom-up surface engineering tool that enables precise control over architecture, composition and structure through sequential assembly of complementary polyelectrolytes.[1,2] For related lipid-based NCR, literature reports enhanced cellular uptake in selected cancer cells (e.g., human ovarian cancer cells) via folic acid surface engineering, enabled by the LbL assembly method.[3]
Accordingly, the purpose of this work was the sequential adsorption of selected polyelectrolytes (including modified chitosan and PEGylated hyaluronic acid) onto the surface of NCR-NPs, to evaluate their effect on skin permeability and cellular uptake. As an active cargo, $ZnGa_2O_4:Cr^{3+}$ NPs showing prolonged afterglow were chosen due to their intriguing optical properties, and the matching of luminescence spectra with the absorption of the chosen photosensitizer. Physicochemical techniques such as electrophoretic and dynamic light scattering (DLS and ELS) were used to control the ζ-potential and size (hydrodynamic diameter) changes due to successive layer deposition. Imaging characteristics of the samples were studied using atomic force microscopy combined with infrared spectroscopy (AFM-IR), providing additional information on their morphology and chemical composition at the nanoscale, allowing for precise confirmation of the nanoplatform self-assembly.
Our study established the successful layer-by-layer adsorption of polyelectrolytes onto the surface of NCR-NPs, as confirmed by ELS and DLS measurements, while AFM-IR provided insight into their morphology and chemical composition. The resulting structures provide a platform with tunable surface functionality and enhanced specificity, along with potential for applications in PDT, enabled by the NPs core.

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