Facile synthesis of monodisperse nanoparticles for biomedical applications

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Abstract: The research and development of new nanotechnologies are still appealing topics in the biomedical field; especially with the clinical introduction of mRNA-based nanoparticles (NPs) to produce vaccines against COVID-19 and other pathologies. Setting-up protocols is a fundamental step because of the industrial production perspective; selecting eco-compatible materials and methods play a role in the decision to scale up the synthesis. All the synthesis parameters affect critical factors of the NPs: size, shape, and surface charge. Controlling their characteristics makes the resulting NPs excellent candidates in drug delivery and diagnosis of malfunctioning biological systems.

Here we present a new facile and fast synthesis to produce biocompatible nanoparticles (NPs) based on poly (isobutylene-alt-maleic anhydride), named PMA. This polymer is made of 39 monomeric units of succinic anhydride easy to react with primary amines. The nanoparticles were prepared by nanoprecipitation, using N, N dimethylformamide (DMF) as the organic phase and adding a sugar, D-glucose to the synthesis, which acts as a thickener allowing spontaneously to obtain monodisperse nanoparticles with a diameter of 50 nm.
Moreover, other NPs were produced using PMA modified with D-glucosamine. This molecule is used as a targeting molecule for specific transporters, GLUTs which regulate the transport of glucose across plasma membranes. In the fabrication of these NPs (GlycoPMA NPs), the grafting must be controlled to obtain a colloidal solution otherwise polymer chains are too hydrophilic avoiding the NPs formation.
These NPs were employed for evaluating the encapsulation capability of various cargos. We selected five molecules with different lipo- and hydro-philicity. One of the molecules is Manganese (II) phthalocyanine. a paramagnetic macrocycle, useful to be exploited as a contrast agent to be used in biomedical imaging.
This research opens the way for the creation of new economical and scalable formulations based on RNA delivery.