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Design and optimization of polymer nanoshuttles for nanomedicine(Conference Paper)

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Current advances in nanotechnology hold the promises to greatly impact on current medical practice. Since nanometric materials interact with cells, tissue and organs at a molecular level, they may be used as probes for ultrasensitive molecular sensing and diagnostic imaging or carriers for drug and gene delivery. However, along with the excitement that has driven the development of novel nanocarriers, there have been increasing concerns regarding the risks these materials may generate. As these nanostructures are intentionally engineered to target specific cells or tissues, it is imperative to ensure their safety. The optimal design of safe and functional nanocarriers for medicine requires a better understanding of the interaction between the physical-chemistry properties of the nanoparticle surface with the complex protein machinery existing at the cell membrane. In particular the effect of the particles properties (charge, shape, protein coating) on the mechanism of cellular uptake is highly relevant both to assess the real biological risks coupled with the use of nanomaterial (nanopathology and nanotoxicology) and to engineer carriers able to improve the medical practice. The nanometric size and the surface molecular decoration may activate mechanisms of cellular uptake different from those commonly used by cells: these open the possibility to activated/modulated the membrane crossing by tuning chemical-physical properties of nanometric materials. In this work, the design and production of novel degradable polymeric nanocavities via layer-by-layer and temperature induced phase separation technology will be presented along with a detailed characterization of their in vitro performances. Furthermore, possible mechanisms of cellular uptake will be discussed and critically presented. The effect of surface bioconjugation on cell membrane crossing will be exploited and elucidated. Particular attention will be devoted to surface molecular decoration able to guide the nanoparticle throughout the cytosol. © 2015 SPIE.