Title:	A Study of the design and Synthesis of polymeric smart Nanocarriers for Delivering Drugs
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Abstract:	Abstract A Study of the Design and Synthesis of Polymeric Smart Nanocarriers for Delivering Drugs Historically, synthetic polymers have been widely used for a wide range of applications due to their structural and mechanical properties. As a result of their inert nature, these polymers are commonly used in biomedical applications, such as coatings and pharmaceutical excipients (implants, dental materials, sutures, contact lenses, drug delivery, etc). Due to the need for highly biocompatible and active materials, polymers from bioactive monomers have been developed, especially antimicrobial and anticancer polymers. Additionally, the current COVID-19 pandemic has prompted a large number of scientists to develop new antimicrobial polymer materials in order to reduce the rise of infections. Due to the lack of new antimicrobial compounds discovered from natural products or novel antimicrobial classes, we have initiated a study to develop drug polymers based on existing antimicrobial compounds. In a number of reports, antimicrobial drugs have been polymerized with spacers or other polymer backbones to form antimicrobial polymers. To understand the importance of spacers in drug polymers, however, the self-polymerization of such drug units has not been explored. In this thesis work, we envisaged that it is possible to self-polymerize 1-cyclopropyl-6-fluoro- 4-oxo-7-piperazine-1-ylquinoline-3-carboxylic acid (ciprofloxacin), a second-generation drug in the class of fluoroquinolones, via a simple synthetic approach based on thermally activated self-condensation. Further, to compare the polymers with and without spacer, we have polymerized the drug (ciprofloxacin) with spacers (C 2 P 2 (29 %) and C 10 P 3 (53 %)) and without spacers (C 0 P 1 0%) by condensation reaction and compared the antibacterial activity of both types of polymers. The trend for minimum inhibitory concentration study against Escherichia coli (E. coli) and Staphylococcus aureus (S. aureus) was observed as 1 > C 0 P 1 > C 2 P 2 = C 10 P 3 >> 2. Furthermore, after coating on nylon threads, the non-spacer polymer C 0 P 1 showed an enhanced zone of inhibition (ZOI) than monomer 1 as well as the spacer polymers with a trend C 0 P 1 > 1 > C 2 P 2 > C 10 P 3 > 2 owing to its superior coating ability and sustained drug release capabilities. Due to the advantages of precisely controlling the size of nanomaterials and the value- adding transition from highly stable polymeric materials, converting polymeric macromolecules into carbonized polymer nanodots (CPD) has become popular. The process provides the formation of carbon nanomaterial by keeping the surface functionality intact,which maintains the activity of functional groups with the benefit of carbon nanodot properties (photoluminescence, ROS generation, catalysis, sensing). The adjacent chapter of this thesis discusses the formation of CPD from the true biocidal polymer C 0 P 1 . In general, due to mixed sizes, doping, and surface effects, carbon dots (CDs) generally exhibit excitation-dependent mixed colour photoluminescence. Herein, a biocidal polymer and solvothermal synthesis have been combined to produce an excitation- independent near-white light-emitting polymeric CPD-C 0 P 1 . As opposed to the parent biocidal polymer, the presence of CPD-C 0 P 1 added strong generation of reactive oxygen species (ROS) in dark condition and cell wall degradation for bactericidal activity and 500-fold increased biocompatibility. In addition to this CPD-C 0 P 1 mediated PMMA NF mat was obtained which was further used as antibacterial-anti-adhesivity surface and potential bacterial cell imaging. As an alternative to traditional drug polymers, smart nanocarriers for controlled, triggered, sustained, cyclic, and tunable release of therapeutic agents have been developed extensively in the last two decades. Stimuli-responsive ‘smart’ polymeric nanomaterials are of significant interest in drug delivery applications. Moreover, the externally triggered-controlled release of hydrophobic drugs has been a leading challenge in the field of drug delivery. This thesis also contributes towards the state of art arrangement of polymers in the competitive environment by dynamic self-sorting behavior of the hydrophobic chains of amphiphilic block-copolymer PEG-PLLA and hydrophobic polymer poly (L-lactide) coated iron oxide nanoparticle IONP@PLLA. A core-shell structure in which the hydrophobic PLLA part acts as a dense core and PEG as an uncrowded shell in mPEG-PLLA has been realized by utilizing system chemistry and nanotechnology principles. The work is a proof-of-concept study, which shows the future possibilities of designing more efficient and improved drug delivery nanocarriers either by changing the polymeric shell structure (chain length, di/tri/multiblock copolymer) or by replacing the nanoparticles in the core. Overall, this thesis contributes towards the development of highly biocompatible polymers and polymeric nanocomposites with enhanced physical properties, biocidal activity, and controlled drug delivery. We believe that studies in the future may explore the synthesis of cyclic polymers and oligomers of antibacterial molecules and their potential activity against antimicrobial-resistant bacteria.
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