Abstract

In this work, new drug delivery systems based on polymeric composite nanofibers as well as mesoporous nanoparticles were synthesized and evaluated with respect to their drug-loading capacity and release as well as antimicrobial properties. Through careful control of manufacturing protocols, electrospun biodegradable fiber mats and mesoporous silica nanoparticles (MSNs) with defined morphology and scalable diameter could be obtained. Combining the electrospinning process with UV photopolymerization allowed for the fabrication of thermosensitive core-shell polycaprolactone-poly(N-isopropylacrylamide) nanofibers which, depending on the temperature of the milieu, provided different release kinetics of the loaded antibiotic doxycycline hyclate (Doxy). The biocompatibility of those fiber mats was demonstrated using *in-vitro* MTT assays, while the antimicrobial activity was proven via *Kirby Bauer* diffusion assays. A dual drug release of rhodamine B and sparfloxacin was demonstrated by incorporating drug-loaded MSNs into the electrospun mats. Synthesis of MSNs with controlled size and homogenous porosity was achieved by combining the well-known sol-gel process with an endo-template method. Moreover, the influence of surface modification on release of Doxy was demonstrated by functionalizing MSNs before and after drug loading with APTMS (3-Aminopropyltrimethoxysilane). The results demonstrated the importance of performed modification steps that was crucial for the observed drug release, as APTMS functionalization after drug loading resulted in lower and slower release of Doxy. To determine the minimal inhibition concentration (MIC) of the antimicrobial molecule Doxy, concentration-dependent studies on two different bacteria types, namely *Escherichia coli and Staphylococcus aureus* were performed. Additionally, ellipsoid-shaped hollow mesoporous silica capsules (HMSNs) were prepared based on etching of elongated core-shell hematite-silica (SiO_2@Fe_2O_3) particles and loaded with Doxy. Drug release kinetics of HMSNs and MSNs revealed that the inner cavity of HMSNs provided not only higher loading capacities but also high release rates of the encapsulated drug. In summary, results obtained in this work demonstrate the promising potential and high biocompatibility of evaluated drug delivery systems (nanofibers and MSNs and composite structures of both materials) and supports their employment for drug release in biomedical applications.