Abstract

Nowadays, there is an increasing risk of bacterial infections from bacteria strains resistant towards antibiotics. Thus, it is of utmost importance to research novel therapies which can overcome this difficulty. The presented thesis focuses on the preparation, characterization and antibacterial evaluation of polystyrene polymer nanomaterials (nanofiber membranes and nanoparticles) modified with compounds that can efficiently inhibit bacterial growth either by their nature (polyethyleneimine) or by photoactivation upon visible light excitation (NO-photodonors, photosensitizers) and consequent production of highly reactive inorganic bactericidal species, nitric oxide (NO) and singlet oxygen ($O_2(^1\Delta_g)$).

All materials were fully characterized by several independent methods. The concentrations of NO and $O_2(^1\Delta_g)$ were measured by amperometric and time-resolved spectroscopic techniques and by variety of chemical analytic procedures. Due to the presence of bactericidal species and the efficient photogeneration of NO and $O_2(^1\Delta_g)$ at physiological conditions, all materials exhibit strong antibacterial action tested on a Gram-negative bacterial strain *Escherichia coli*. Hence, these functionalized polymer nanomaterials may be intriguing systems for medical-, biological-, or environmental- application where a sterile environment has to be introduced and/or maintained.

Furthermore, the proof of concept of utilizing nanofiber membranes as multifunctional systems mainly for biomedical applications was shown. The polystyrene nanofiber membrane was modified by covalent attachment of biotin which readily binds to avidin or its conjugates to form the strongest known non-covalent interaction. To validate the successful functionalization of nanofibers with biotin-avidin system, the horseradish peroxidase and its preserved enzyme activity after the binding to nanofibers was used. The functionalization of nanofiber membranes with biotin open the general way of binding biotin/avidin derivatives with different functionalities to nanofiber surface.