9. Outlook

Core-multishell architectures introduced in this thesis can be tailored to further enhance their host-guest properties and apply them in fields such as drug delivery, catalysis, antibacterial and fungicidal agents, universal stabilizers, and gene transfection.

Optimization of nanotransporter properties should be focused on structural modification. In the first place the length of the nonpolar domain should be increased. The greatest effect on transport capacity was observed with change of dicarboxylic acid from C_6 to C_{18}.[366] Therefore prolongation of the inner shell to C_{36} or more atoms should result in significant transport capacity improvement. Not only chain length but also composition of nonpolar domain and its influence on nanotransporter properties should be investigated in the future. The use of fluorinated chains is a important potentially attractive modification. This would allow encapsulation of fluorinated guest molecules as support in catalysis.[210] Exchange of the linear aliphatic chain with branched structure or cholesterol-derivative molecules could enhance the encapsulation efficiency of nonpolar molecules.

Outer (polar) shell modifications should include the prolongation of mPEG chain lengths to 40 – 50 glycol units (or more) as claimed in literature to be the most efficient in transport capacity enhancement.[350] Exchange of mPEG chains with denser shell, e.g., PG should lead to reduction of aggregation phenomenon and unimolecular type of transport.

Modification of the core size should be held towards both smaller and bigger hyperbranched polymers. The use of a smaller core should result in better transport capacity on nonpolar molecules while nanotransporters with bigger cores should possess higher TC for polar molecules.

Concurrently to domain size and type modifications, introduction of additional functional groups should be performed. This includes introduction of environment sensitive linkers into the core-shell structure. Cleavage of the chains triggered by external stimulation or conditions change will lead to aggregate destabilization and release of encapsulated guest molecules. This is important for drug or gene delivery applications. As examples of the linkers pH sensitive acetal,[333,356] imine,[356] hydrazine,[333,440-442] or ortho ester[328] groups should be highlighted. Acid cleavable systems will be triggered by pH drop after endocytosis[233] or in the intercellular space in tumors and inflamed tissues.[317] As redox (reductive condition) sensitive linkers disulfides groups should be incorporated into the nanotransporter structures. The rationale behind this approach is that the cytoplasm has a lower redox potential and substantially more molecules with free sulfhydryl groups such as glutathione than plasma. This leads to a reduction of disulfides in cytoplasm and consequently to cleavage of the linkers.[322] Also enzymatically cleavable,[316] photosensitive,[320,321] and thermosensitive[318,319] groups should be taken into consideration.

Another attractive direction of core-multishell architecture development would be introduction of various targeting groups attached to the outer shell of nanotransporters.[251] This will allowed alternative to EPR a cellular targeting of the nanotransporters.

Additionally to the synthesis of the new types of core-multishell nanotransporters, the further investigation of abilities and potential applications of existing systems should be continued. Currently the most promising and the most potential direction of development is encapsulation of metal ions and metal nanoparticle creation.[357,363]

In the first order antibacterial and fungicidal properties of silver loaded core-shell systems should be further optimized. Mixtures of ion loaded and nanoparticle loaded nanotransporters should be investigated to obtain efficient antibacterial agents with long activity time. Also various additions of other metals and organic compounds to silver-complexed polymers should be tested towards reaching higher activity.

Complexes of core-multishell architectures and various metals such as gold, silver, palladium, platinum, ruthenium, copper, and nickel should be tested for their stability and catalytical activity. Tests should be conducted for metal ions as well as for metal manoparticles in organic and aqueous environments. Also, mixtures of different metals should be investigated.[357,363] [361,364,443,444]

Further applications of core-multishell architectures can be found in the area of cosmetics and dyes (nanoinks) industry as stabilizers and solubilizing agents.