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Synthesis and Applications of Polydopamine/Protein Nanoparticles

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The rise of nanotechnology in all parts of our daily lives provides great opportunity for technological advances. Be it in the field of medicine or energy production, the particular properties of nanosized materials have allowed for novel approaches. Polydopamine, a structural relative of melanin, has recently gained attention due to its biocompatibility, versatility and ability to transform light into heat. Herein, a novel one-pot synthesis of polydopamine nanoparticles containing functional proteins is presented and examined for its critical components.

The application of the polydopamine nanoparticles as a phototherapeutic agent was explored in the treatment of cancer, a disease with considerable therapeutic shortcomings and mortality. To this end, polydopamine nanoparticles containing transferrin, a protein crucial for the iron metabolism and extensively used for the targeting of cancer cells, were produced. Mouse melanoma cells readily incorporated polydopamine/transferrin nanoparticles. Upon irradiation with light, the cells were found to undergo apoptosis. This process was accelerated significantly in the presence of the polydopamine/transferrin particles. These results indicate the possibility of polydopamine nanoparticles being used as a phototherapeutic agent. The versatility of the system, as provided by the interchangeability of the incorporated protein, could prove to be a major advantage in targeting different kinds of cancer.

In addition to the application in medicine, the polydopamine nanoparticles were also investigated as a dopant for heat transfer fluids in solar thermal energy collectors. With the focus on renewable energies being stronger than ever, advances in this field are sought after. Even though doping heat transfer fluids have been researched since the 1970s, previously investigated dopants have high production costs and low stability, being associated with clogging of the solar collectors. Polydopamine nanoparticles with incorporated bovine serum albumin were found to alleviate these shortcomings while providing a considerable increase in collector efficiency. In conclusion, polydopamine/protein nanoparticles show a tremendous potential for various applications due to their versatility, cost efficiency and biocompatility.

Jury:
Prof. Dr. Barbara Rothen-Rutishauser (thesis supervisor)
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