Research Project
ProteinATRP-Protein-based ATRP catalysts: From Nanoreactors to ATRPases

Third-party funded project

Project title ProteinATRP-Protein-based ATRP catalysts: From Nanoreactors to ATRPases
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Atom Transfer Radical Polymerization (ATRP) is the most successful and widely applied controlled radical polymerization process and has emerged as one of the most powerful synthetic techniques in polymer science. Chain termination reactions are suppressed and the growth of the chains proceeds in a controlled way. It allows precise control of the polymer’s molecular weight, achieving a narrow molecular weight distribution and synthesis of polymers with complex molecular architectures, such as block copolymers. However, the major drawback of ATRP is the residual toxic copper ions found in the final polymer products.

I propose to investigate protein-based catalysts for the mediation of ATRP. The methodology developed during my Marie Curie fellowship, the conjugation of appropriate ligands to defined sites on protein surfaces, will be used. ATRP catalysts will be obtained in which the active complex is encapsulated in a cage like protein nanoreactor, or where the catalyst is exposed on the surface of fluorescent proteins. The nanoreactors will be explored to synthesize individual amphiphilic block copolymer chains in a hydrophilic nanocompartment. This system allows studying the folding of individual amphiphilic block copolymer chains. On the other hand, fluorescent proteins will be explored as efficient means to remove copper from the polymerization solution, and to monitor such removal by observing the location of fluorescence. With this system, homo and block copolymers will be synthesized that are acceptable for application in biomedical and food-grade applications because of their low copper ion content. Last but not least, naturally occurring metalloproteins, such as hemoglobin, peroxidase and cytochromes, will be explored as ATRP catalysts in aqueous and in nonaqueous solutions. As these proteins are non-toxic and available in large quantities, they could become the ATRP catalysts of the future.

Keywords Atom transfer radical polymerization, ATRP, protein cage, nanoreactor, artificial metalloenzyme, non-natural enzyme activity, blockcopolymer, single-chain polymer particle

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