Thermo-responsive biopolymers

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Regulation and activation by molecular conformational switches is widely observed in living cells and include thermally functionally and structurally responsive proteins (e.g Taq polymerase or Elastin respectively), chemo-responsive structural proteins (actin-myosin proteins in muscles) and a large number of chemoreceptors, photoreceptors, voltage sensors and other molecular sensors. Despite these, the engineering of artificial thermo responsive molecules so far relied on nucleic acids. Most exploited applications are DNA origami and molecular beacons to name a few. DNA based self-assembling complexes are relatively easy to predict and generate because the affinity and the strength of interaction mostly depend on the degree of sequence complementarity and even long and complex structures are remarkably predictable. However no such principles apply to protein–protein interactions which are often impossible to predict, therefore rational engineering of controllable self -assembling proteins remains a major challenge.

Disadvantages of nucleic acid based self-assembled systems include the existence of multiple cellular mechanisms evolved to resist foreign DNA or RNA invasions and the low stability of DNA assemblies in many liquid media, including pure water. It is not surprising therefore that the approach taken by nature relies on proteins as structural and functional biopolymers, as well as conformational switches. Until recently the progress in engineering protein based stimuli-responsive biopolymers have been slow and mostly limited to the use of randomly aggregating elastin-like peptides. Protein engineering efforts so far were focused on achieving controlled assembly of protein based polymers whilst equally important controlled disassembly was neglected by the scientific community.

Engineering of responsive biopolymers necessitates the use of non-destructive methods for real time structural investigation such as CD spectroscopy, scanning calorimetry, UV-Vis and fluorescent spectroscopy. Here we report the application of CD spectroscopy to the analysis of engineered self-assembling proteins. We achieved controlled assembly and thermally responsive disassembly of protein-based polymers. Such protein based system allows for the first time reversible and thermally responsive controllable protein-based biopolymers.