National Aeronautics and Space Administration

A Versatile Platform For Nanotechnology Based On Circular Permutations Of Chaperonin Protein

NASA has developed a versatile platform with the potential to provide new self-assembling and/or self repairing devices applicable to a range of commercial areas. This invention provides compositions and methods for templates for making chaperonin subunit polypeptides, which are modified by relocating the N- and C-terminal to different positions. The modified chaperonin subunit polypeptides can assemble as part of chaperonin structures and the relocated N- and C-terminal ends can be linked to, or bind with, organic or inorganic molecules. The modified chaperonin polypeptides fold into subunits that self-assemble into double-ringed chaperonin structures, and it organize into higher-order structures such as two-dimensional crystals and filaments. Additionally, the reporter peptide is functional. The assembled chaperonin structures are useful for producing ordered nanoscale materials, devices, nanoscale filaments or two-dimensional crystals having functions produced by the linked or bound organic or inorganic molecule. Development of methods for ordering nanoscale materials through "bottom-up" assembly provides new tools for creating nanostructured materials and devices that self-assemble or self-repair. The controlled organization of inorganic materials into multi-dimensional addressable arrays is the foundation for both logic and memory devices, as well as other nonlinear optical and sensing devices.

Patent

This technology has been patented.
U.S. Patent No. 7,795,388
(Reference No. ARC-14744-2)

Benefits

- Protein-based templates that can self assemble
- Accurate
- Nano scale resolution
- hybrid bio/inorganic approach
- Organizational basis
- Highly ordered structure
- Can be attained on a very small material
- Diversity of the chaperonin system

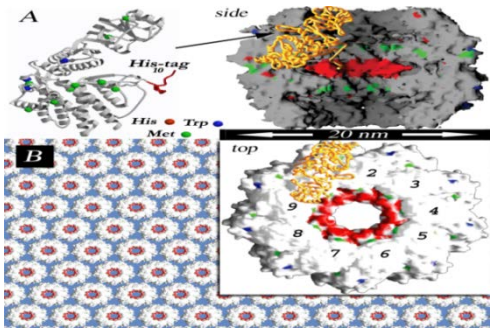
This invention is available for licensing from NASA's space program to benefit U.S. industry.

Technology Details

This invention provides chaperonin polypeptides which are modified to include N-terminal and C-terminal ends that are relocated from central pore region to various different positions in the polypeptide which are located on the exterior of the folded modified chaperonin polypeptide. A number of protein complexes have been developed as nanoscale templates. These can be functionalized using peptide sequences that bind inorganic materials or by fusion to binding or catalytic proteins. In order to integrate peptides and proteins into specific positions in a protein template, circular permutation is used to relocate the amino and carboxy termini of the polypeptide chain. Additional sequences can then be joined to the protein termini. This minimizes disruption of the protein structure and reduces restrictions on size and conformation of the added sequence. Relocating the termini of the subunits to the outside of the double ring would facilitate fusion of a greater variety of peptides and proteins to the chaperonin. This reordering of protein sequences, known as circular permutation, has been used to elucidate protein thermodynamics and function, to create single-chain variants to multimeric proteins and to identify sites that are permissive for insertions. Circular permutation is generally performed at the genetic level.

Commercial Applications

- Semiconductor Industry
- Biomedical
- Field emitters, sensors
- Biochips
- Optical switches, lenses, probes
- Nanoelectroni-mechanical systems
- Neural networks, nanoquantum computers
- High-density magnetic memory or storage media
- Amplifiers for telecommunications



Assembly of engineered chaperonin templates

Contact the Ames Technology Partnerships Office at 1-855-627-2249 or ARC-TechTransfer@mail.nasa.gov