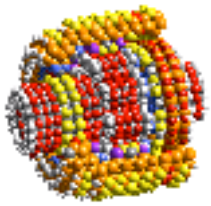

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Steps Toward Nanotechnology

By Jeffrey Soreff

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Structural Components

Stiff, strong, atomically precise parts to bear loads, transmit forces, and hold active parts in position are essential parts of any nanomachine design. The papers summarized in this section describe advances in the synthesis of these components.

"Two groups modified a 33-residue peptide called GCN4. One group replaced 4 leucine (a hydrophobic amino acid) residues with trifluoroleucine. The other group [Kumar] replaced 4 leucines and 3 valines (another hydrophobic amino acid) with fluorinated versions. In both cases the groups were able to increase the stability of the peptides above that of the natural versions. These peptides form dimers. The first group increased the temperature to which these dimers are stable by 13 °C, the second group by 15 °C.

In natural peptides and proteins, a major contributor to the stability of the folded structure is essentially a phase separation between a core of hydrophobic amino acid residues and the water in which the molecule is dissolved. In these new structures "immiscibility of fluorous phases in water and many organic solvents... provide[s the] driving force for fluorinated amino acid side chains to collapse into a fluorous core." Because this adds a third phase to the usual aqueous/hydrocarbon separation, it adds considerable design freedom to protein design. This is important to nanotechnology because proteins can fold into atomically precise 3D structures, and protein synthesis permits a great range of design freedom, so improving our ability to predict and control folded protein structures improves the range of precise 3D structures that we can build.

Perhaps one can proceed further along these lines. There is a classic demonstration of seven mutually immiscible liquids: heptane, aniline, water, perfluoro-kerosene, phosphorous, gallium, and mercury. Natural proteins use two (perhaps three, if one counts aniline as analogous to tryptophan) of these phases. This work adds a third phase. Perhaps all of these phases can eventually be used to control the tertiary structure of synthetic proteins."

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