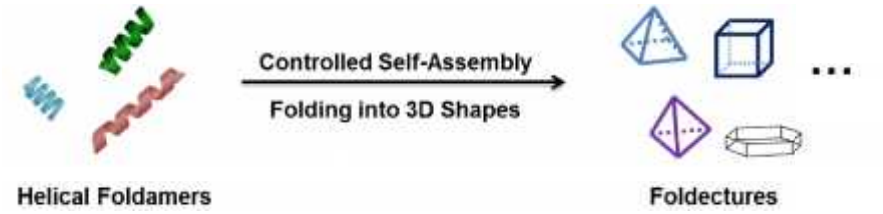
Foldectures: Unprecedented 3D Organic Molecular Architectures

Hee-Seung Lee

Molecular-Level Interface Research Center, Department of Chemistry, KAIST, Daejeon 305-701, Korea

It has been well known that creatures in nature, even very small living organisms such as bacteria and diatoms, have various shapes of 3D structures. This means that particular 3D shapes should be closely related to many biological functions, which in turn suggests that 3D shapes are necessary tools to recognize or communicate each other for maintaining their living systems.Molecular self-assembly is the spontaneous assembly of molecules into structured aggregates by which nature builds complex 3D functional systems.

While numerous examples have focused on 2D self-assembly to understand the underlying mechanism and mimic this process to create artificial nano- and microstructures, a limited progress has been made toward 3D self-assembly on the molecular level. This lack of progress is partially due to the difficultly of designing and using nondirectional noncovalent interactions, such as van der Waals and hydrophobic interactions, in synthetic, nonbiological molecular systems. Thus, we sought to establish a set of self-assembling components that could be linked to observable 3D shapes by which the governing parameters of self-assembly could be disentangled and tractable. Recently, we discovered for the first time that artificial protein fragments (helical β-peptide foldamers) with well-defined hydrophobic surfaces self-assembled to form unprecedented 3D molecular architectures ("foldectures") in a controlled manner in aqueous solution. We anticipate that our strategy can be a starting point for the rational design of 3D organic molecular architectures with various functions. Furthermore, the self-assembly behavior of artificial protein fragments will be relevant for the development of synthetic foldamer proteins.



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Hee-Seung Lee, Korean.b. 1967 in Seoul, Republic of Korea.He is currently an Associate Professor at the Department of Chemistry, KAIST. He obtained B.S(1990), M.S. (1992), and Ph.D.(1996)degrees at KAIST (Prof. Sung Ho Kang). After he worked at Samsung Fine Chemicals as Senior Scientist (1996–1999), he joined the group of Prof. Sam Gellman at the University of Wisconsin-Madison as a postdoctoral fellow. He started his independent career at KAIST in 2004. His research is mainly focusing on the study of self-associating behavior of foldamers to construct biocompatible 3D molecular architectures for diverse applications.