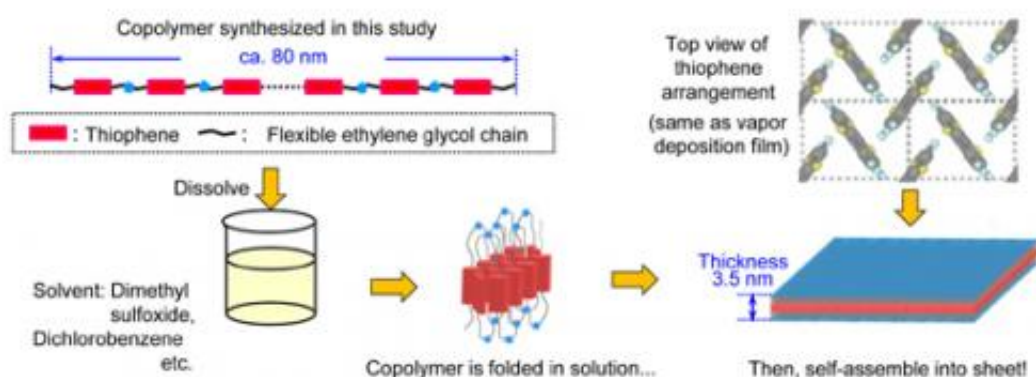


2D organic materials: World's first synthesis of thiophene nanosheets with 3.5nm thickness

April 25 2013



Schematic diagram of the supramolecular thiophene nanosheet formation process.

A team of researchers from the National Institute of Material Science and the Max Plank Institute for Polymer Research has developed the world's first supramolecular thiophene nanosheets, which is a 2-dimensional organic material with a thickness of 3.5nm.

In recent years, electronic materials with 2-dimensional sheet structures such as "Graphene" have attracted considerable attention. However, in the case of graphene, size control is difficult, and chemical functionalization of the graphene surface is impossible. On the other hand, the thiophene derivatives have been actively investigated as electronic materials for [field effect transistors](#) (FET), [organic solar cells](#),

organic electroluminescence (organic EL) materials, and other applications. However, the manufacturing process of thiophene thin film has many problems. For instance, vacuum vapor deposition requires much energy and expensive equipment. Although thin film [fabrication method](#) via simple wet process have been developed using a [polymer solution](#), it is difficult to obtain polymer thin films with high crystallinity. In this research, Dr. Ikeda overcame these problems and found a facile manufacturing method of thiophene nanosheets with high [crystallinity](#) in the solution.

In this work, Dr. Ikeda discovered that an alternating copolymer, in which a thiophene derivative and flexible [ethylene glycol](#) chain are alternately connected, is folded in some [organic solvents](#) in such a way that the thiophene units are stacked each other, and the folded copolymers self-assemble into a 2-dimensional sheet structure (Figure). Although the length of the polymer used in this work is approximately 80nm, the thickness of the sheet is only 3.5nm due to the folded conformation of the copolymer. The arrangement of the thiophene units in the nanosheet was confirmed to be the same as that manufactured by vacuum [vapor-deposition](#) of low-molecular-weight thiophene compounds. Therefore, our thiophene nanosheets are feasible to the application of organic electronics devices. The lateral size of the nanosheet was controllable by tuning the concentration of the polymer solution. The chemical modification of the nanosheet surface was also possible by introducing the other functional unit at the terminals of the copolymer.

Since it is possible to fabricate monolayers like those manufactured by vacuum deposition by just dissolving a polymer in a solvent, this method will lead to simple, low-cost and energy-efficient device fabrication. The self-assembly process via polymer folding reported herein is also of great scientific interest, as it artificially reproduces the folding and self-assembly of proteins in nature.

This research achievement was published online on March 26 (local time) in the international scientific journal *Angewandte Chemie International Edition* of the German Chemical Society, and was selected by the Editorial Board of that journal as a "hot paper."

Provided by National Institute for Materials Science

Citation: 2D organic materials: World's first synthesis of thiophene nanosheets with 3.5nm thickness (2013, April 25) retrieved 20 March 2024 from <https://phys.org/news/2013-04-2d-materials-world-synthesis-thiophene.html>

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