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Molecular wires with a twist

Researchers at Osaka University synthesized molecular wires with periodic twists separating rigid fused regions to increase the electrical conductivity, which may lead to the development of cheaper and biocompatible electronic devices

Osaka, Japan – From the high-voltage wires that carry electricity over long distances, to the tungsten filaments in our incandescent lights, we may have become accustomed to thinking that electrical conductors are always made of metal. But for decades, scientists have been working on advanced materials based on carbon-based oligomer chains that can also conduct electricity. These include the organic light-emitting devices found in some modern smartphones and computers.

In quantum mechanics, electrons are not just point particles with definite positions, but rather can become 'delocalized' over a region. A molecule with a long stretch of alternating single- and double-bonds is said to have pi-conjugation, and conductive polymers operate by allowing delocalized electrons to hop between pi-conjugated regions – somewhat like a frog hopping between nearby puddles. However, the efficiency of this process is limited by differences in the energy levels of adjacent regions. Fabricating oligomers and polymers with more uniform energy levels can lead to higher electrical conductivity, which is necessary for the development of new practical organic electronics, or even single-molecule wires.

Now, in a study recently published in *The Journal of the American Chemical Society*, researchers from SANKEN (The Institute of Scientific and Industrial Research), at Osaka University have created several nanometer-scale molecular wires with periodic twists. Compared with previous attempts that used one long chain that could rotate randomly, these oligomers consisted of rigid fused regions separated by evenly spaced twists. The researchers showed that their samples exhibited higher conductance compared with that found in non-fused oligothiophenes. "By carefully controlling the size of these pi-conjugated

regions, high single-molecule conductance was achieved in these oligomers using rigid molecular structures," says Ryo Asakawa, lead author of the study.

The researchers hope that this method can be applied to fabricate new organic electronic devices, which can be made more cheaply as thin chemical films applied to flexible substrates, compared with conventional silicon-based methods, which often require special clean rooms to produce using lithography. "We expect this research will lead to better single-molecule electronics and organic thin-film devices," says senior author Yutaka Ie. Individual molecular wires might even be used as biocompatible sensors inside living cells.

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The article, "Periodically Twisted Molecular Wires Based on a Fused Unit for Efficient Intramolecular Hopping Transport," was published in *The Journal of the American Chemical Society* at DOI: https://doi.org/10.1021/jacs.4c07548

Summary: Researchers from Osaka University developed molecular wires with periodic twists. By controlling the lengths of regions between twists, the electrical conductivity of individual polymer chains can be enhanced. This work may lead to novel organic electronics or single-molecule wires.

Tweet: Crowing achievement? @osaka_univ_e created necklace-like #molecular #wires

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Nanofibers,
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Asia Research News トップに表示する図として使用：Fig.1

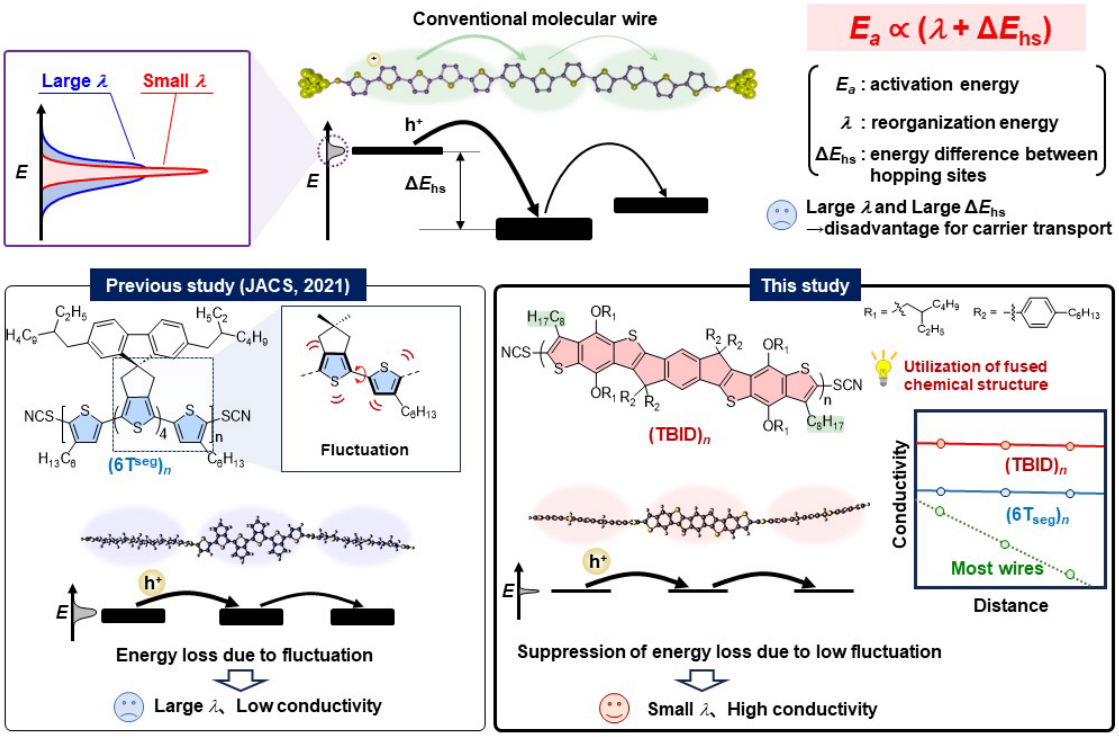

Fig. 1
キャプション: Development of periodically twisted molecular wires

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