Nanoblinds: Helical polymer with side groups that synchronously flip 'on command'

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Some molecules occur in two versions related to each other like mirror images; this property is called chirality. For example, helical polymers are chiral - they can be either left- or right-handed helices. The left and right versions differ in their optical properties, such as their optical activity (they twist the plane of polarized light in opposite directions).

Molecules whose optical properties can be precisely controlled - and switched - are highly sought after, as they present interesting possibilities for new data storage devices, optical components, or liquid-crystal displays. American researchers have now developed a helical polymer with side groups that can be flipped back and forth synchronously, like Venetian blinds.

The research team headed by Bruce M. Novak from North Carolina State University and Prasad L. Polavarpu from Vanderbilt University produced a helical polymer from an achiral building block. The use of a chiral catalyst made it possible to link the monomers exclusively into helices twisted in the same direction. Raising the temperature or changing the solvent causes a sudden—and reversible—change in some of the polymer's optical properties (optical activity and electronic circular dichroism); contrary to expectations, one other property (vibrational circular dichroism) remains unchanged. What is happening with this molecule? Does the direction of the helix change? The researchers have now been able to prove that isn't the case.

The backbone of the polymer remains the same. The only explanation for these initially contradictory seeming observations is the following: the polymer has side chains that stick out from the backbone at an angle, like little flat wings. All of these "wings" twist around the bond that attaches them to the backbone. In the end, they point in the opposite direction, relative to the helix, from where they started. This occurs synchronously, like a Venetian blind being flipped.

Why does raising the temperature or changing the solvent cause this flip? The two wing positions are not equivalent. Depending on the polarity of the solvent, one or the other form of the molecule is stabilized. A higher temperature stabilizes the less energetically favorable form of the molecule, a lower temperature stabilizes the more energetically favorable form.

"The coordinated, blind-like flipping of the many side groups as the result of an external stimulus," says Novak, " could also indicate a very interesting potential for the construction of molecular motors and nanomachines."

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