Creating a chiral polymer from achiral monomers using a magnetic field

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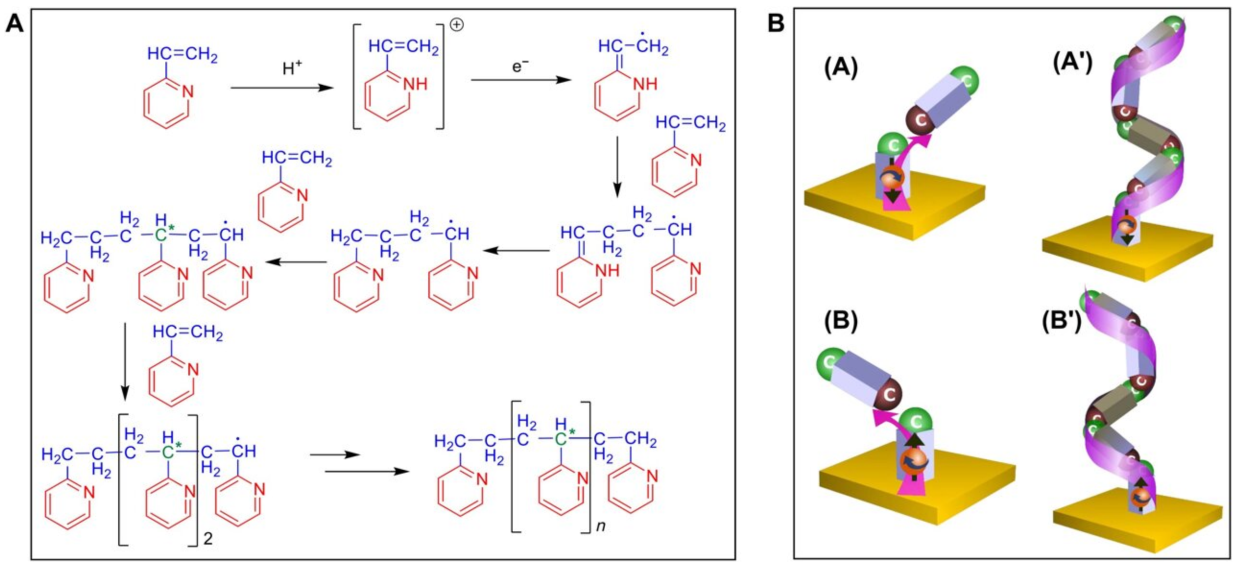

Schematic and a proposed mechanism of the electropolymerization process of 2-vinylpyridine. (A) Schematic of the electropolymerization process of 2-vinylpyridine (25). (B) Schematic of a proposed mechanism for enantioselective polymerization in the presence of spin-polarized electrons. After the adsorption of the first monomer on the electrode (yellow), a second monomer is adsorbed either in the pro–right-handed (A) or in the pro–left-handed (B) configuration. Spin-polarized electrons are transferred from the electrode into the complex formed. Which spin polarization is injected depends on the magnetization direction of the substrate. One spin-polarized electron (the sphere with an arrow) is preferred for the right-handed configuration, and the opposite spin is preferentially transferred for the left-handed structure. The asymmetric carbon is denoted in green. The sequential polymerization continues, and accordingly, either right-handed (A′) or left-handed structures (B′) are formed. No evidence for the secondary structure of the polymer could be obtained. Credit: *Science Advances* (2022). DOI: 10.1126/sciadv.abq2727

A combined team of researchers from the Weizmann Institute and the Israel Institute of Technology, both in Israel, has developed a way to create a chiral polymer from achiral monomers using a magnetic field as a way to align the spin of the electrons that are involved in bond formation. In their paper published in the journal *Science Advances*, the group describes their technique and possible uses for it in spintronics.

Creating molecules with mirror image properties is important in many chemical processes—pharmaceuticals are perhaps one of the most well-known. Such molecules have chirality, which means they are mirrors of other molecules that allow for strong bonding. An analogy would be two hands pressed up against one another. Creating such molecules tends to be a long and difficult process. In this new effort, the researchers have developed a way to way to simplify the process in one type of application by using monomers to create a single chiral polymer.

The work by the team involved placing a monomer molecule on an electrode and altering the direction of the flow of the current beneath it as a means of controlling the magnetic field on the electrode surface as additional monomers were added. Doing so allowed for spin-polarized electrons to be controlled as they were absorbed up into the body of the molecule, and that allowed for manipulating the shape of the polymer as it grew. The result was a chiral polymer with a desired shape.

The researchers note that they were able to maintain the "handedness" of each new stereocenter throughout the process, though they acknowledge that such control grew weaker as the polymer chains grew in length (which made them more distant from the electrode). Even so, they found that they were able to control the action at distances up to 100 nm.

Using the new technique, the researchers note, could allow for the production of chiral polymers without the need for chiral catalysts or even chiral reagents, which are typically discarded after the reactions are complete, representing a reduction in waste and cost. They suggest it might also lead to helping explain why molecules in living creatures are almost all single enantiomers.

More information: Deb Kumar Bhowmick et al, Spin-induced asymmetry reaction—The formation of asymmetric carbon by electropolymerization, *Science Advances* (2022). DOI: 10.1126/sciadv.abq2727