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Pursuing safer, cheaper pharmaceuticals via electromagnetic control at the atomic level

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The research led by Dr. Shoufeng Lan could produce safer, less costly generic pharmaceuticals. Credit: Texas A&M Engineering

Commonplace pharmaceuticals, such as ibuprofen, can carry with them an inherent flaw in their atomic structure, which pairs the active, beneficial ingredient with a potentially ineffective—or even toxic—counterpart. New research could hold the key to more easily isolating the good while removing the unwanted.

Dr. Shoufeng Lan, assistant professor in the J. Mike Walker '66 Department of Mechanical Engineering at Texas A&M University, is leading a team investigating the use of electromagnetic control over the synthesis of chiral compounds at an atomic level—a process that could lead to a plethora of practical applications, including in the pharmaceutical industry. The team's research was recently published in the journal *Nature Communications*.

"Mysteriously, all living organisms on the Earth consist of only left-handed amino acids and right-handed sugars, but not their mirrored counterparts," Lan said. "The phenomenon is the so-called homochirality of life and it is the ultimate form of asymmetric synthesis."

Lan used the example of a human hand to demonstrate the concept of chirality, noting that if you were to create a mirror image of your hand, it could not be perfectly superimposed over the original.

By identifying a successful method of using asymmetrical synthesis to create new versions of structures for items like ibuprofen, Lan said better versions of generic pharmaceuticals with reduced toxicity could be created at a lower cost than currently available due to the current purification process.

However, to achieve success, the researchers will first need to overcome the practical need to implement this magnetic effect on asymmetric synthesis at room temperature. Currently, this effect is relatively weak, even with a strong magnetic field or at a temperature as low as -450 degrees F (-268 C).

Lan said the topic of addressing chirality was the basis of the 2001 Nobel Prize in chemistry, which uses an existing chiral object—a catalyst molecule—to transfer chirality to the desired mirror image form as the final product.

"This *Nature Communications* paper demonstrated a giant atomic-scale magneto-chiral effect that is orders of magnitude stronger," Lan said. "By applying this effect, it is arguably possible to master an asymmetric synthesis or asymmetric self-assembling."

Lan said his team's research could prove revolutionary to the field by creating a new iteration of biomedical, chemical and pharmaceutical applications. For example, by asymmetrically synthesizing only the active component of racemic Lexapro—the most common medication in the United States with more than 25 million prescriptions—the research might reduce the drug's side effects.

"We anticipate that our demonstration could lead to the creation of chiral seeds at the atomic scale," Lan said. "Upon them, we hope to transfer the chirality using cutting-edge technologies, such as a metal-organic framework, to create chiral materials from nanoscales to macroscales."

More information: Shoufeng Lan et al, Observation of strong excitonic magneto-chiral anisotropy in twisted bilayer van der Waals crystals, *Nature Communications* (2021). DOI: 10.1038/s41467-021-22412-9

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