Scientists learn how to make oxygen 'perform' for them

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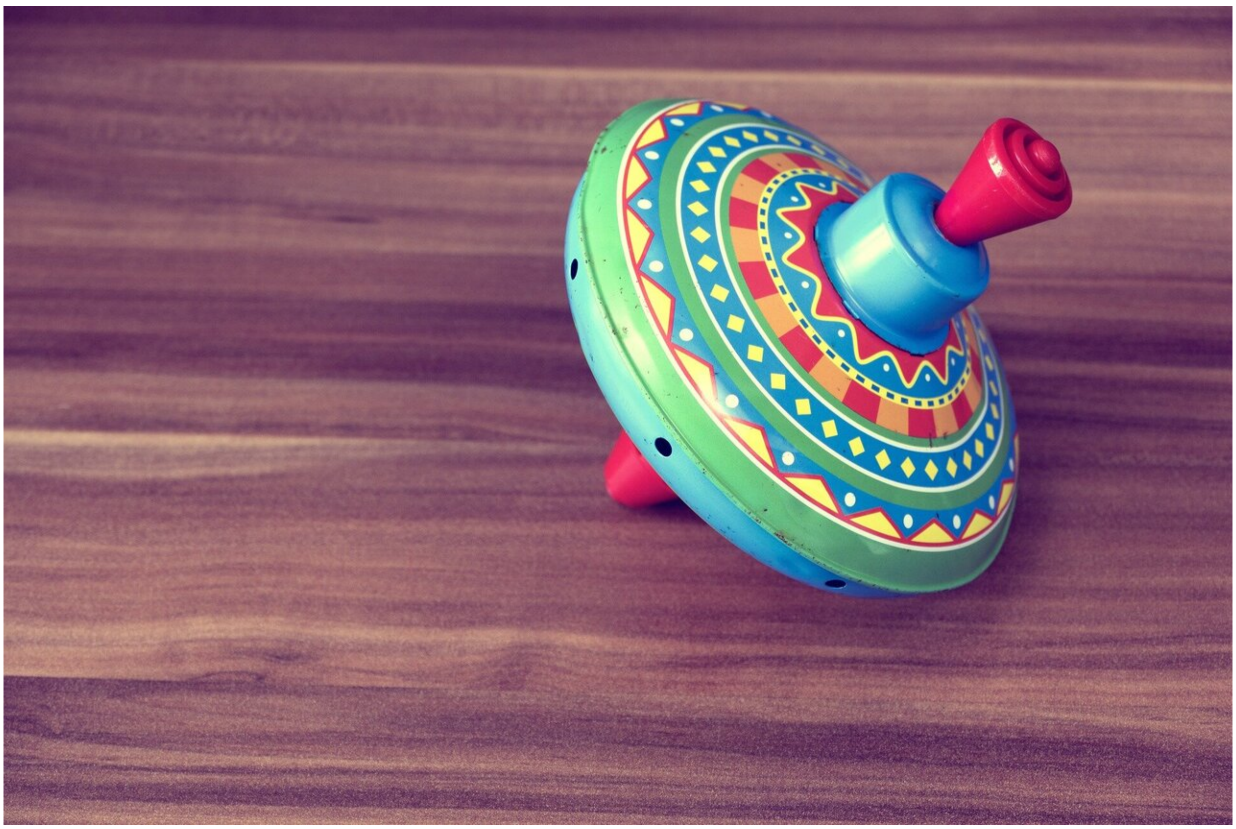

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When it comes to the fundamentals of making better materials—stronger-but-thinner glass for televisions or phone screens, for example—it almost always comes down to the building blocks of science. Understand the structure around an atom, the most basic piece of any material, and you might be able to change that material for the better.

But studying atoms can be difficult, especially for certain elements. One particular isotope of oxygen, for example, is notoriously tricky for scientists to evaluate, because the best tool for the job—something called nuclear magnetic resonance spectroscopy—doesn't keep the isotopes moving long enough to study it well.

"We wanted to look at oxygen, but getting details about oxygen structures has been challenging over the years because we couldn't observe the collective behavior of these oxygen isotopes long enough," said Philip Grandinetti, a professor in The Ohio State University Department of Chemistry and Biochemistry.

Think of it like a stadium wave—if only one person does the wave, and does it for only a few seconds, the wave won't be especially noticeable. But if everyone in a stadium does the wave, and keeps it going for a few minutes or more, it might be possible to learn some things about the wave, because you can see it happening and measure specific elements about it: its speed, for example, or the percentage of people wearing scarlet or gray while doing it.

A team of researchers at Ohio State has figured out how to keep "the wave" of one particular isotope of oxygen—among the most abundant elements on the planet and a crucial building block for materials like glass and ceramics—going during nuclear magnetic resonance spectroscopy long enough to learn some things about its structure and function.

"And understanding the structure around oxygen allows you to create better materials from it—better glass, better ceramics," said Grandinetti, who is also senior author of a study about the discovery published

Monday, Oct. 28, in the journal *Physical Review B*.

To understand nuclear magnetic resonance spectroscopy, consider a toy top. Drop the top with a flick of your wrist, and the top spins almost perpendicular to the surface on which it is spinning. But nudge it with your finger, and the angle about which the top is spinning starts changing. That change in angle is something scientists call "precession"—and the same thing happens to atoms being evaluated using nuclear magnetic resonance spectroscopy.

To study this particular isotope of oxygen, oxygen 17, using a nuclear magnetic resonance spectroscopy machine, scientists "hit" the atoms with radiowaves, changing the angle about which the isotopes precess.

What they found is that the angle matters, especially for an oxygen 17 isotope: At just the right angles, the isotopes' "wave" lasts much longer than is typical. Usually, this "wave" lasts only a few milliseconds—hardly anything at all. But Grandinetti and his team discovered how to extend the "wave"—what they call the nuclear magnetic resonance coherence lifetime—of oxygen 17 up to five minutes. That creates a much larger window during which scientists can study the isotope. This lifetime extension leads to a million-fold reduction in the time required to do an O-17 NMR measurement.

"This is the kind of building block science that helps scientists design better materials," Grandinetti said. "The longer scientists can study this isotope, the more they can learn about it. And then after that the world is your oyster—you can start learning how to use this element to make materials stronger, or lighter, or whatever you need it to be."

More information: Daniel Jardón-Álvarez et al, Natural abundance O17 and S33 nuclear magnetic resonance spectroscopy in solids achieved through extended coherence lifetimes, *Physical Review B*

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