Molecular tug-of-war could lead to new materials

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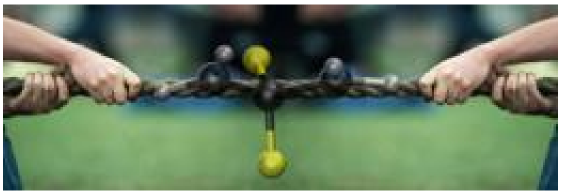

Scientists are tugging on molecules to make new materials. Credit: Stephen Craig, Duke.

Tug-of-war isn't just for play. In the chemistry world, the game could identify a Saran-wrap-like material that instantly heals microscopic tears in its own structure.

Duke scientists are testing this idea using atomic forceps to tug on individual molecules. They've already discovered that a slight pull can pop open rare, triangle-shaped molecular structures in milliseconds.

The usual way to open these molecules is to heat them at high temperatures - overnight, said chemist Stephen Craig, who described his research at a colloquium on March 3. With the molecular tug-of-war, Craig foresees a microscopic world where scientists could almost instantly move molecules and atoms to create new materials and even new chemistry.

Craig and his colleagues recently explored how molecule chains, called polymers, can snap back to structures smaller than their original forms. The team also trapped a molecule in the middle of the reaction that made it shrink. Typically that halfway point, called a "transition state," lasts for less than one millionth of a millionth of a second, but Craig's team succeeded in "catching lightning in a bottle," which may be useful in understanding the electronic properties of the transition state.

To quantify the tug-of-war at the molecular level requires an atomic force microscope. Craig sees the tool like a diving board. When a particularly heavy person or tough molecule is on the end, the board bends way down. Measuring the bend of the microscope's board, the team can put a number to the force or strength of the molecule being tugged.

The microscope can pull harder and harder on the chain until it breaks, which shows the polymers that can endure the "heaviest diver" or most force. His team can also use the tool to watch if specific molecules change their shapes, such as opening and closing their triangle structures, as the polymer starts to break apart.

By seeing this new chemistry as it happens, Craig and other scientists could learn how to move atoms and molecules where they need them. The manipulation provides scientists with another way to create new materials for applications from longer-lasting coatings on artificial hips to plastic wrapping that never gets holes.

Provided by Duke University