Scientists develop molecular keypad lock

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Keypad locks, such as those for preventing auto theft, allow an action to take place only when the right password is entered: a series of numbers punched in a pre-set sequence. Now, a team of scientists at the Weizmann Institute of Science has created a molecule that can function as an ultra-miniaturized version of a keypad locking mechanism. Their work appeared in the *Journal of the American Chemical Society*.

The molecule, synthesized in the lab of Prof. Abraham Shanzer of the Organic Chemistry Department, is composed of two smaller linked units – fluorescent probes – separated by a molecular chain to which iron can bind. One of these probes can shine bright fluorescent blue and the other fluorescent green, but only if the surrounding conditions are right. These conditions are the keypad inputs: Rather than the electric pulses of an electronic keypad, they consist of iron ions, acids, bases, and ultraviolet light.

Shanzer and his group, which includes Drs. David Margulies, Galina Melman and Clifford Felder, have demonstrated in the past that such molecules can be used as logic gates, such as those that form the basis of computer operations. As opposed to electronic logic gates, in which electrical switches flip ON and OFF, the team's molecules, with various combinations of chemical and light inputs, can switch between colors and light intensities to perform arithmetic calculations.

The challenge in creating a keypad lock was in generating sequences that can be distinguished one from another. Entering the sequence 2+3+4 will yield the same result as 3+4+2 on a calculator, but a keypad lock set to one password (234) won't open for the other (342). The scientists found that by controlling the opening rate of the logic gate within the reaction time frame, they were able to produce different, distinguishable outputs, depending on the input order. By adding light energy, which also influences the molecules' glow, they were able to produce a molecule-size device that lights up only when the correct chemical 'passwords' are introduced. "It's just like a tiny ATM banking machine," says Shanzer.

Although these minuscule keypads are not likely to become a practical alternative to today's anti-theft devices, Shanzer believes this example of a molecular keypad lock – the first of its kind – will lead to new ideas and inventions in other areas such as information security and even medicine. "Faster and more powerful molecular locks could serve as the smallest ID tags, providing the ultimate defense against forgery." In the future, molecular keypads might prove valuable, as well, in designing 'smart' diagnostic equipment to detect the release of biological molecules or changes in conditions that indicate
disease.

Source: American Committee for the Weizmann Institute of Science

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