World's first digitally-encoded synthetic polymers

June 5 2015

Researchers have for the first time succeeded in recording a binary code on a synthetic polymer. Inspired by the capacity of DNA to retain an enormous amount of genetic information, a team from the Institut Charles Sadron de Strasbourg (CNRS) and the Institut de chimie radicalaire (CNRS/Aix Marseille Université) synthesized and read a multi-bit message on an artificial polymer. The results were published in *Nature Communications* on May 26, 2015.

With its 3.4 billion base pairs, human DNA can compile a tremendous amount of information in a tiny space. All of the information stored is expressed using four nitrogenous bases: A, T, G and C. Researchers had previously been able to use the sequencing of these veritable molecular building blocks to reproduce a binary code. However, the technical limits of DNA made it necessary to develop the first synthetic polymer —cheaper, more malleable and able to store binary information. This has now been achieved for the first time by a team of French scientists from the CNRS and Aix-Marseille Université.

Instead of using the four nitrogenous bases of DNA, in this study the researchers used three monomers . Two of these monomers represent the binary code numbers 0 and 1, and can be used interchangeably during synthesis. A third nitroxide monomer was inserted between the bits in order to facilitate the writing and reading of the coded sequence.

A short binary message is synthesized by hand, monomer by monomer on a growing chain. The operation takes approximately a day, but should

be quicker once automated. Decoding is done by sequencing, in the same way that DNA has been decoded for decades. A mass spectrometer thus takes less than five minutes to decipher the information—a duration also destined to be reduced in the short term.

While sequencing systematically destroys the polymer, it is also possible to erase the code at any time and without reading it, by exposure to temperatures above 60ºC or to a laser. Researchers showed that at room temperature, the polymer can be conserved for a number of months, and could even last several years given the molecule's stability.

The team hopes to store messages of a few kilobytes or even megabytes within 3 to 5 years. This technique, patented by the CNRS, also makes it possible to develop molecular barcodes in the short term. Sequences could provide labeling that would be extremely difficult to falsify, ideal for high value-added products such as luxury goods and medicine. The use of monomers and secret codes, known only to the laboratory and the industrial partner, would make it very difficult to produce counterfeits.

More information: "Design and synthesis of digitally encoded polymers that can be decoded and erased." *Nature Communications* 6, Article number: 7237 DOI: 10.1038/ncomms8237

Provided by CNRS