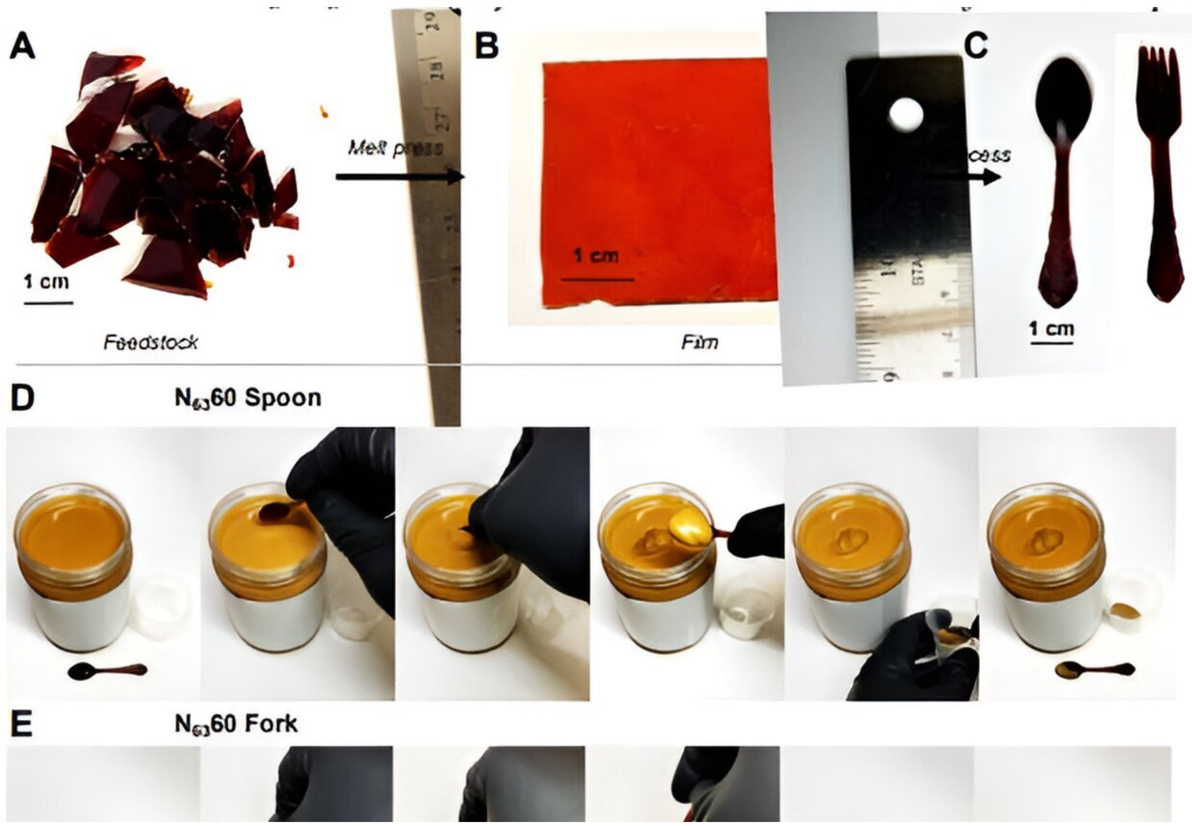
A type of plastic that can be shape-shifted using tempering

February 2 2024, by Bob Yirka



Applications from a single feedstock. A, Batch of as-cast, dried N_{63}. B, Freestanding film of N_{63}. C, $N_{63}60$ spoon and fork. D, Demonstration of $N_{63}60$ as a rigid spoon to scoop peanut butter. E, Demonstration of $N_{63}60$ as a rigid fork to pick up a piece of cheese. F, Demonstration of $N_{63}110$ as a pressure-sensitive adhesive. G, Demonstration of $N_{63}60$ immediately failing as an adhesive. Credit: *Science* (2024). DOI: 10.1126/science.adi5009

A team of molecular engineers have developed a type of plastic that can be shape-shifted using tempering. In their paper published in the journal *Science* the team, from the University of Chicago, with a colleagues from the US DEVCOM Army Research Laboratory, Aberdeen Proving Ground, the National Institutes of Standards and Technology and the NASA Glenn Research Center, describe how they made their plastic and how well it was able to shape shift when they applied various types of tempering.

Haley McAllister and Julia Kalow, with Northwestern University, have published a Perspective piece in the same issue of *Science* outlining the work.

Over the past several years, it has become evident that the use of plastics in products is harmful to not only the environment but also human health—bits of plastic have been found in the soil, the atmosphere, the oceans, and the human body.

Consequently, scientists have begun looking for ways to reduce the amount of plastic that is created, used and dumped into the trash. In this new effort, the research team has created a type of plastic that can be converted to something new once its initial purpose has been exhausted—using tempering. A plastic bag holding food, for example, could be converted to a fork or spoon.

To allow for such shape-shifting, the researchers developed a type of plastic using a dynamic cross-linked approach that was based on the reversible addition of thiols to benzalcyanoacetates—a process known as a "Michael addition." The resulting plastic was of a type that could be modified by tempering, which is where a material is heated to a certain point, then chilled quickly. Tempering is most often associated with metalwork.

The researchers found by that heating the plastic to temperatures ranging between 60°C and 110°C, then transferring it to a standard food freezer, they could create different objects from the same material based on a whim.

They created a spoon first, which they used to scoop peanut butter from a jar. They then used tempering to change the spoon to a fork, and then to an adhesive material capable of holding two panes of glass together. However, tests showed that there was a limit to the number of times the plastic could be changed, which was seven times. After that, it began to degrade.

More information: Nicholas R. Boynton et al, Accessing pluripotent materials through tempering of dynamic covalent polymer networks, *Science* (2024). DOI: 10.1126/science.adi5009

Haley P. McAllister et al, Plastics that lose their temper on demand, *Science* (2024). DOI: 10.1126/science.adn3980

Citation: A type of plastic that can be shape-shifted using tempering (2024, February 2) retrieved 27 April 2024 from https://phys.org/news/2024-02-plastic-shifted-tempering.html