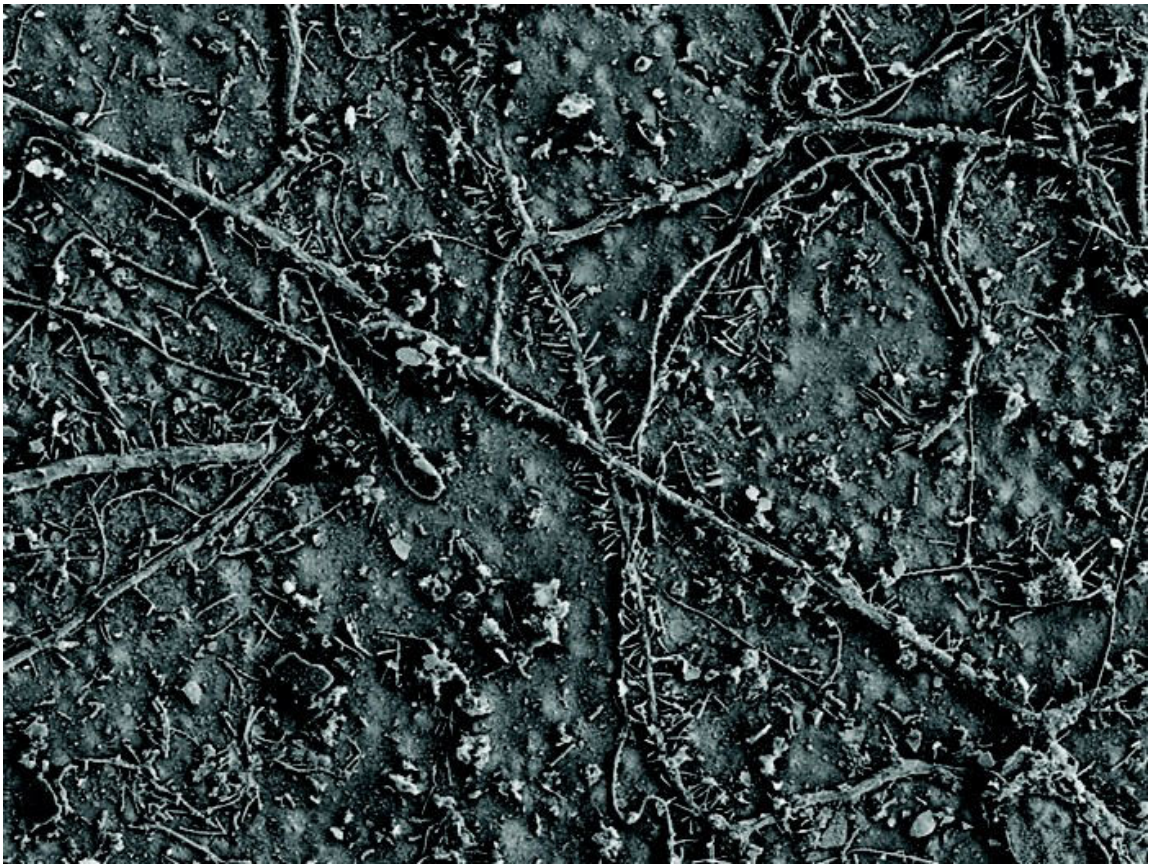
SUSTAINABILITY

Technique tracks carbon as soil microbes munch plastic

Isotope labeling and spectroscopy allow scientists to watch how soil microbes break down a mulch product used in agriculture

by ***Carmen Drahl***

JULY 31, 2018



Credit: ETH Zurich/Environmental Chemistry Group

Numerous microbial colonies dot the surface of the biodegradable films, as shown in this scanning electron microscope image.

To keep weeds at bay and retain soil moisture, farmers apply plastic "mulch" to their fields. But these thin polymer films are tough to collect again, and accumulating plastic can reduce soil fertility. Biodegradable plastic mulches avoid those issues and are gaining prominence. Researchers have now developed what some experts say is the most comprehensive method yet for tracking where carbon from one of these polymers goes in soil.

To distinguish polymer carbon from soil carbon, Michael Sander and colleagues at ETH Zurich used a mulch film, poly(butylene adipate-*co*-terephthalate), with ^{13}C at certain spots within the polymer. They filled glass bottles with polymer samples and 60 grams of soil. Over six weeks, the team followed release of isotope-labeled CO_2—a sign that **soil microbes had metabolized the polymer**

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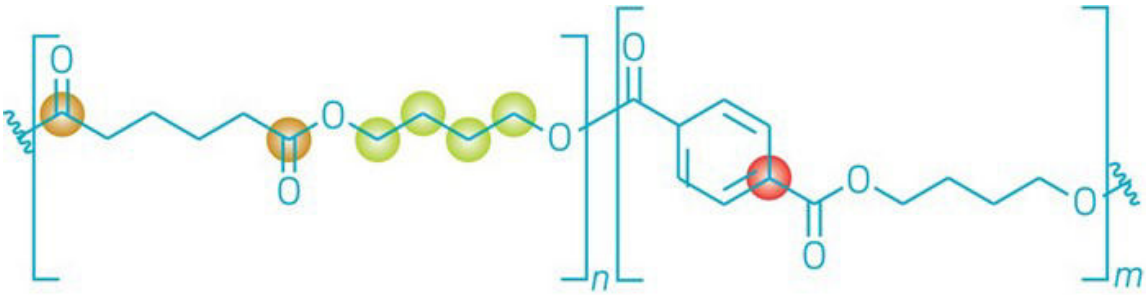
—with cavity ring-down spectroscopy. They tested different polymer samples with isotope labels in each of three different subunits (shown). The microbes broke down all the polymer components, but the rate of isotope-labeled CO_2 release differed depending on where the label was within the polymer. On the basis of NMR studies, the team concluded that the difference was largely due to different rates of enzyme hydrolysis for the various polymer subunits (*Sci. Adv.* 2018, **DOI: 10.1126/sciadv.aas9024**).



Poly(butylene adipate-*co*-terephthalate)

Colored balls (gold, green, red) denote the locations of ^{13}C labels in different samples of a biodegradable polymer.

ETH graduate student Michael Zumstein visited coauthors in Vienna to use nanoscale secondary ion mass spectrometry to map the distribution of ^{13}C isotopes on the surface of polymer samples colonized by soil microbes. By analyzing the intensity of the ^{13}C signals, the researchers could confirm that plastic-colonizing microbes incorporated carbon from the polymer into their biomass. "They're not just breaking the mulch into microplastic. They're actually eating it," says ETH coauthor Kristopher McNeill.

"This study shows nicely that carbon from different positions in a biodegradable polymer indeed transfer into biomass and CO_2, and that this happens at different rates for different carbon atoms," says soil scientist Markus Flury at Washington State University. He would like to see a long-term study to demonstrate that the polymer can be completely consumed; the six-week study showed only partial degradation. He'd also like to know the fate of plastic mulch additives that confer properties such as resistance to ultraviolet light to the materials.

"Additives are on the to-do list," Sander says. His team is currently conducting longer-term tests in different soils and plans to conduct field tests as well. The work was supported in part by BASF, which makes the biodegradable polymer.

A number of scientists want to determine whether microbes can also break down other polymers that are more resistant to biodegradation, such as polyethylene. Prior investigations haven't provided definitive answers, but this technology likely would, says Till Opatz, who's studied plastic biodegradation at the University of Mainz.

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