Don’t throw out those used coffee grounds—use them for 3D printing instead

Enlarge / A pendant, espresso cups, and flower planters 3D-printed from used coffee grounds.
Michael Rivera

reader comments

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Most coffee lovers typically dump the used grounds from their morning cuppa straight into the trash; those more environmentally inclined might use them for composting. But if you’re looking for a truly novel application for coffee grounds, consider using them as a sustainable material for 3D printing, as suggested by a recent paper published in DIS ’23: Proceedings of the 2023 ACM Designing Interactive Systems Conference.

“You can make a lot of things with coffee grounds,” said co-author Michael Rivera of the University of Colorado, Boulder, and the ATLAS Institute, who specializes in digital fabrication and human-computer interactions. “And when you don’t want it anymore, you can throw it back into a coffee grinder and use the grounds to print again. Our vision is that you could just pick up a few things at a supermarket and online and get going.”

As 3D printers have moved into more widespread use, it has sparked concerns about environmental sustainability, from the high energy consumption to the thermoplastics used as a

printing material—most commonly polylactic acid (PLA). PLA waste usually ends up in a landfill where it can take as long as 1,000 years to decompose, per Rivera. While there have been efforts to recycle PLA in the same way plastic (PET) soda bottles are typically recycled, it's an energy-intensive process that can't be done by the average user at home. Adding biomass fillers (bamboo or hemp fiber, oyster shells, and yes, spent coffee grounds) makes recycling even more labor and energy intensive.

So many researchers are casting about for promising sustainable alternatives to thermoplastics. For instance, last year we reported that scientists from The Hebrew University of Jerusalem had created wood ink derived from wood waste (with no added synthetic resin) that can be extruded into flat wooden structures, self-morphing into complex 3D shapes as they dry and shrink. The technique could one day be used to make furniture or other wooden products that could be shipped flat to a destination and then dried to form the desired final shape. There may even come a day when detritus from pruning trees or fallen leaves can be recycled to make the wood ink, removing the need to transport wood materials to build (or rebuild) chairs or tables, for example.

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Rivera's use of coffee grounds as a 3D-printing medium has similar objectives. "I was doing a lot of work in 3D printing, prototyping a lot, and realizing that I was generating buckets of waste for things I didn't need or couldn't use or needed to redesign," he said. He began searching for ways to make the process more sustainable and realized, "We actually waste a lot of the bio-based materials that are naturally biodegradable and compostable."

Inspiration struck while Rivera was a graduate student at Carnegie Mellon University and a regular at Arriviste Coffee Roasters cafe in Pittsburgh. The used coffee grounds were composted by a local group until the COVID-19 pandemic hit,

when the owner was forced to start throwing the grounds out. Rivera remembered the owner’s dilemma when he became a postdoc at University of Colorado Boulder and was casting about for sustainable alternatives for 3D printing. Coffee grounds seemed like a viable option. “When you do the extraction for brewing a drink [of coffee] you’re only drinking about 20 percent of what’s in that bean,” said Rivera. “The spent coffee grounds are the other 80 percent of the material that’s there.”

Enlarge / A modified 3D printer fabricates a flower planter from used coffee grounds.
Michael Rivera

Arriviste supplied Rivera with spent coffee grounds from making espresso-based drinks like lattes and cappuccinos. The grounds were dried in direct sunlight over two days rather than drying them in an oven to reduce energy consumption for the process. The dried grounds were sifted with a standard kitchen strainer to remove large clumps and then mixed with xanthan gum and carboxymethyl cellulose powders, which serve a similar purpose to binders, stabilizers, and thickeners.

Finally, that mixture was combined with water (proportional by mass), and the resulting paste was loaded into 60 mL syringes for use in a modified consumer-grade 3D printer. (Rivera's adapter design is open-sourced.) No heat is required during the printing process.

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The finished 3D-printed objects are as strong as unreinforced concrete, per Rivera. His team has made small planters to grow seedlings, which can be transferred to a garden—biodegradable planter and all—when the resulting plants are ready. They've made decorative pendants and espresso cups out of this new material. And they created 3D-printed prototype user interfaces for human-computer interactions that changed shape due to shrinkage as they dried—a single-layer square morphing into a saddle shape, for example, or a rectangular rod that bent upwards as it dried.

According to Rivera *et al.*, the coffee ground 3D-printing material could also be used to make biodegradable capacitive touch sensors. Even though the material is not conductive on its own, it can be combined with activated charcoal powder derived from coconut shells—either as a surface coating or mixed directly into the coffee ground material. His team was able to 3D-print prototype sensors in different shapes (a hollow cube and a triangle) and test them by using a wire to connect the prototypes to a resistor and microcontroller. "We were able to sense basic interactions like proximity and a touch gesture" using the prototypes, the authors wrote.

[embedded content]

Researchers at the University of Colorado Boulder are using old coffee grounds to 3D-print a wide range of objects—from jewelry to pots for plants and even, fittingly, coffee cups.

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