Microalgae as SLA 3D printing material

Researchers
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Focus
We developed the first (and only so far), microalgae-based 3D printing material for SLA printers. This material can help with: Dematerialization: it is one of the main points of using 3D printing Biomass: the production of this material (microalgae) uses less water and land compared to plant-based materials - CO2 capturing: microalgae can be fine-tuned to capture an even higher amount of CO2 from the environment

Innovative idea and objective

3D printers are an excellent tool for **dematerialization** as they can print on demand, only the needed object, and directly in the place where it is needed. In addition, Microalgae are **biomass** that requires way less water and land than plants. They can be tuned to capture more CO2 and convert it selectively to the material needed, improving **CO2 sequestration**.

Due to the associated sustainability, our **innovative idea is to use microalgae as SLA 3D printing material**.

Relevance to the materials transition in textiles and/or building materials?

3D printing is already used widely as a repairing method. Missing or broken parts can be efficiently designed and fabricated on-site and in a household setup. The technique can be applied to repair household items i.e., broken furniture but can also be used to produce and personalize fashion items. With SLA 3D printing, the end consumer can design and print custom items such as buttons, belt buckles, and zippers. These haberdasheries can be made to precisely match the part that needs replacement, allowing the consumer to restore the garment to its initial state. Providing consumers with the option to repair instead of discarding them could reduce the amount of fashion waste that currently piles up in waste fields and the need to produce new items.
Additionally, 3D printing allows for the personalisation of different items by printing decorative items such as pins and jewelry. Personalisation creates a personal bond of the user with the item, thus keeping it for longer before discarding it.
Complementary to the apparent reduction of waste by repairing, the parts necessary for the repair can be made from sustainable materials, like the microalgae oil-based resin developed in this project, that do not rely on fossil carbon for their production.
Therefore, SLA 3D printing resin from microalgae oil can indirectly reduce the use of fossil carbon in the domain of textiles and building materials through repairing instead of discarding and directly by using bio-based and CO2-capturing feedstock to produce the repairing parts instead of the fossil-based that are being currently used.

What did you do?

Microalgae oil is rich in unsaturated fatty acids. The double bonds of these fatty acids can be exploited to insert functional groups.

In our case, the fatty acid double bonds were transformed into epoxide groups through an epoxidation reaction. In a subsequent step, methacrylate groups were inserted in the locations of the highly reactive epoxides, yielding a potentially photopolymerizable product (Scheme 1). The reactions were optimized to increase the yield and to check the possibility of scaling up. The products of each reaction were detected using NMR spectroscopy. Using the final product of the methacrylation reaction, we formulated a resin that cures under UV light. Overall, from a starting amount of 100 g of microalgae oil, we produced 83 g

of printable resin, of which 44 g were of bio-based origin. The dynamic mechanical analysis of the printed microalgae oil-based resin remains to be done and is scheduled for February 2023.

Main result, achievement and highlight

For the first time, we proved that it is possible to produce 3D printing SLA resin using microalgae oil as starting material. The proof of concept worked, and we could 3D print earrings from the microalgae biobased material.

Figure 1. 3D printed earrings using microalgae-based resin.

Microalgae leftover dried material can be embedded in the resin up to 10%, reducing the resin used in the final product.

Key message

We developed the first (and only so far), microalgae-based 3D printing material for SLA printers. This material can help with:

- Dematerialization: it is one of the main points of using 3D printing
- Biomass: the production of this material (microalgae) uses less water and land compared to plant-based materials
- CO2 capturing: microalgae can be fine-tuned to capture an even higher amount of CO2 from the environment

Visual abstract

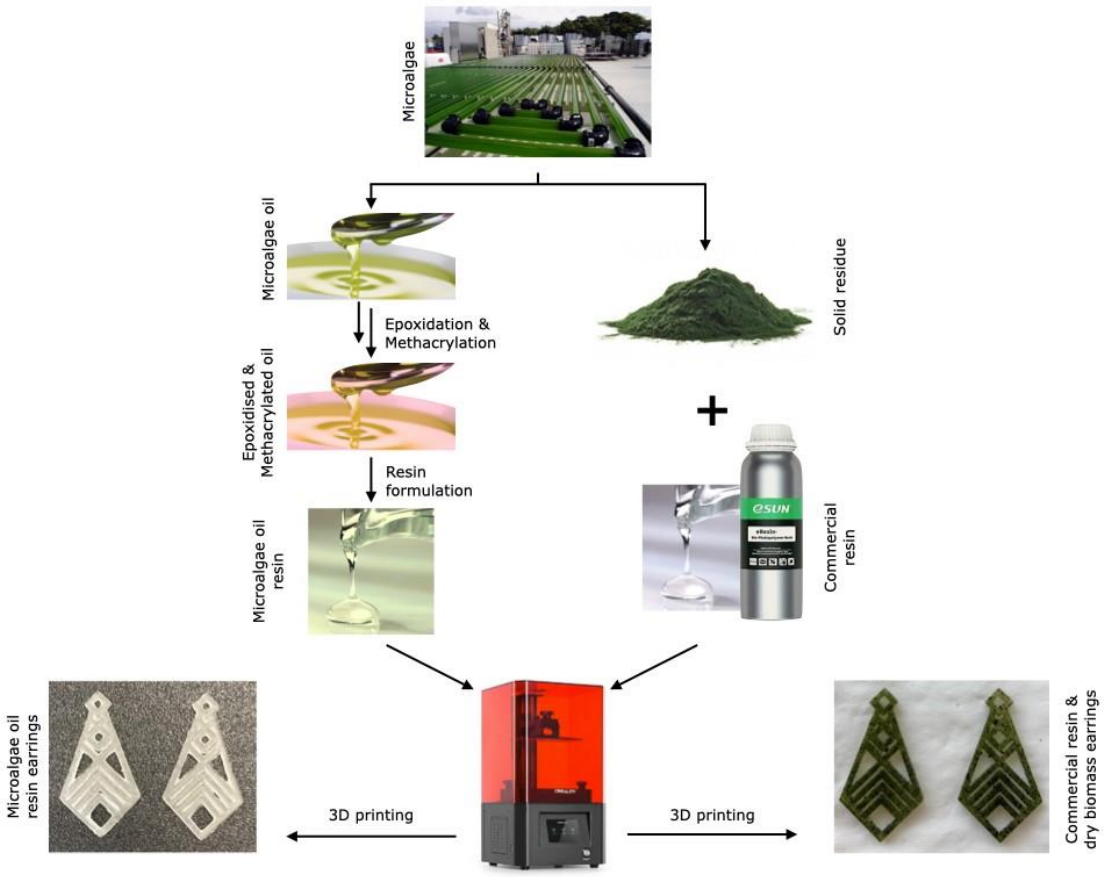

Figure 2. From microalgae to 3D-printed earrings. Microalgae oil was chemically processed to formulate photocurable 3D printing resin from which a pair of earrings was printed. The same earrings design was also printed using a commercially available resin mixed with microalgae biomass, reducing the amount of polymers needed.