Objective

The objective of this work is to revalorize lignin and sawdust via 3D printing using bioepoxy as a carrier. However, just the incorporation of these particles within the polymer matrix does not improve the rheological properties of the bioepoxy enough to be 3D printable. Keeping this in mind, we sought to shift the burden in 3D printing from materials to a processing method, so otherwise unprintable materials can be printed.

- We propose a new 3D-printing processing technique termed Delayed Extrusion of Cold Masterbatch (DECMA), which enables the 3D printing of thermoset biocomposites.
  - In this technique, the degree of curing of the ink is controlled via time/temperature conditions. Then, the resin is cooled down to stop the reaction and the printing is started.
  - We aimed to systematically investigate the printability of the biocomposite paste and assess the merits of the delayed extrusion via DECMA.

Set-up

- The samples were 3D printed with an in-house developed piston-driven extrusion system to guarantee a constant paste dispensing speed.
  - The paste extrusion process was performed at a piston speed (dispensing speed) 0.6 mL/min and a print speed of 200 mm/min.
  - Objects were manufactured with a layer height of 1.5 mm, utilizing 2 mm nozzles.

Conclusion

- A bioepoxy-based ink containing a 20% of sawdust and 15% of lignin (with a total bio-based content of 58–71%) was developed.
  - The incorporation of lignin and sawdust increased the starting viscosity of the mixture from 103 to 105 mPa-s and provided shear-thinning behavior without affecting the curing kinetic.
  - It was found that the ink was not printable using the direct printing approach, but using DECMA, several parts (i.e., cuboids, adjoining lines, parallel lines, and honeycomb) were successfully printed.
  - Additionally, 3D-printed parts could easily be machined, thereby showcasing potential for hybrid manufacturing.

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