Final Report

Project acronym: *3DPrintInn*

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2. Publishable project summary

The need for durable, sustainable materials continues to grow with time, even as researchers come up with new and creative means of processing materials and producing parts via advancing manufacturing techniques. One such technique that has become very popular not only among reserachers but also within the general population more broadly is additive manufacturing, more commonly referred to as 3D printing. By building up materials layer by layer, 3D printers represent an exciting new means of generating complex parts of arbitrary geometry using relatively inexpensive equipment. In this project, we have focused on a specific form of 3D printing known as vat photopolymerization, whereby light induces the local solidification of a liquid polymer "ink", thanks to its ability to yield dense, high quality parts at high resolution. One drawback to this type of 3D printing is the fact that most of the polymer inks available for use in such printers are petroleum based. In this context, our methodology has been to focus on the formulation of polymer inks that combine printability with a significant bio-based content and attractive properties. Soybean oil forms the basis for these inks, with mechanical reinforcement provided by lignocellulosic fillers. These particles of biomass-based cellulose and / or lignin remain well-mixed thanks to a combination of their small size and the application of optimized surface modification techniques to ensure good compatibility with the liquid resin. This also helps to ensure that they offer minimal interference to the beam of light to which the polymer ink is exposed in order to induce solidification. This is further achieved through careful control of the concentration of these fillers, which is likewise important for controlling viscosity and mechanical performance. While balancing all of these concerns is quite challenging, in the end the team was able to show that it is indeed possible to formulate both unreinforced and reinforced polymer inks with a significant bio-based content, to succesfully adapt these formulations to 3D printing, and to generate a variety of complex parts using these novel bio-based materials. This outcome provides clear evidence of both the potential and the practicality of using more sustainable materials solutions in additive manufacturing.