

## Life Cycle Assessment of 3D printed Coir Pith/Poly Lactic Acid Sustainable Composites for Automotive Interior Application

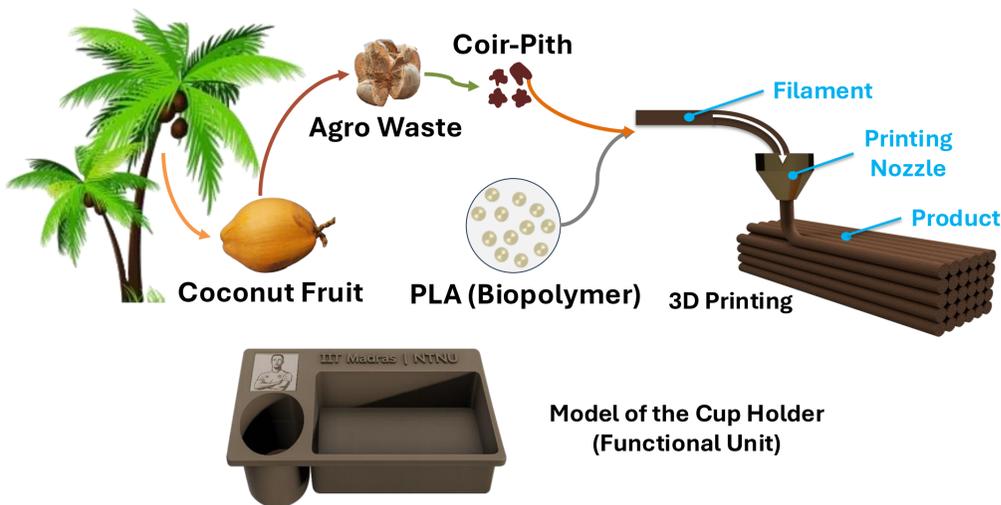
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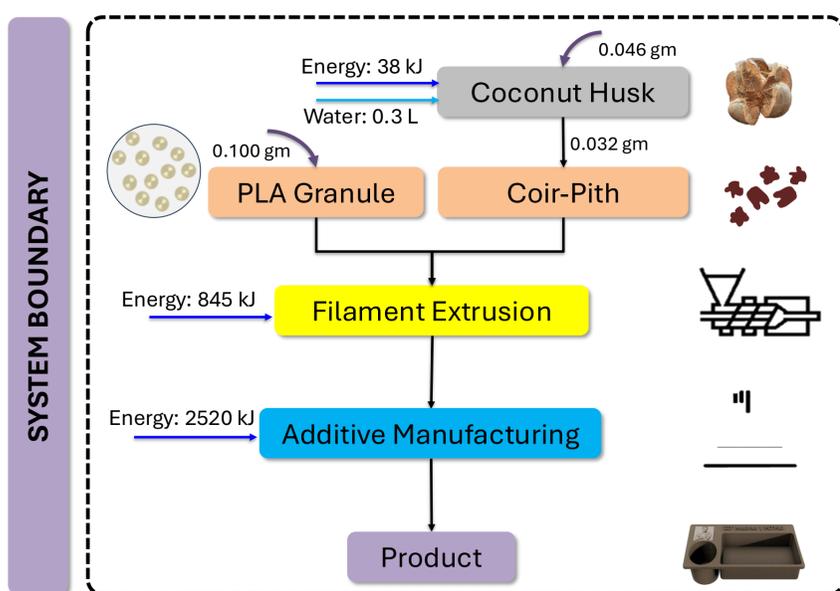
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### INTRODUCTION

- ❖ Personalized custom automotive interiors designed to satisfy the expectations of future generations and the growing reliance on bio-based materials [1,2] are key priorities for the automotive industry.
- ❖ A cup holder, used to hold refreshment containers, made of 25 vol% coir-pith/ Poly Lactic Acid (PLA) composite produced via personalised additive manufacturing, is considered the functional unit.



### PRODUCT DEVELOPMENT PROCESS & LIFE CYCLE ASSESSMENT METHODOLOGY



#### Inventory Data

- ❖ The inventory data for coir-pith extraction from coconut husk were collected during the field survey in Southern India.
- ❖ The coir-pith reinforced PLA composite filament making and 3D printing process resource inventory data were referred from the in-house equipment.

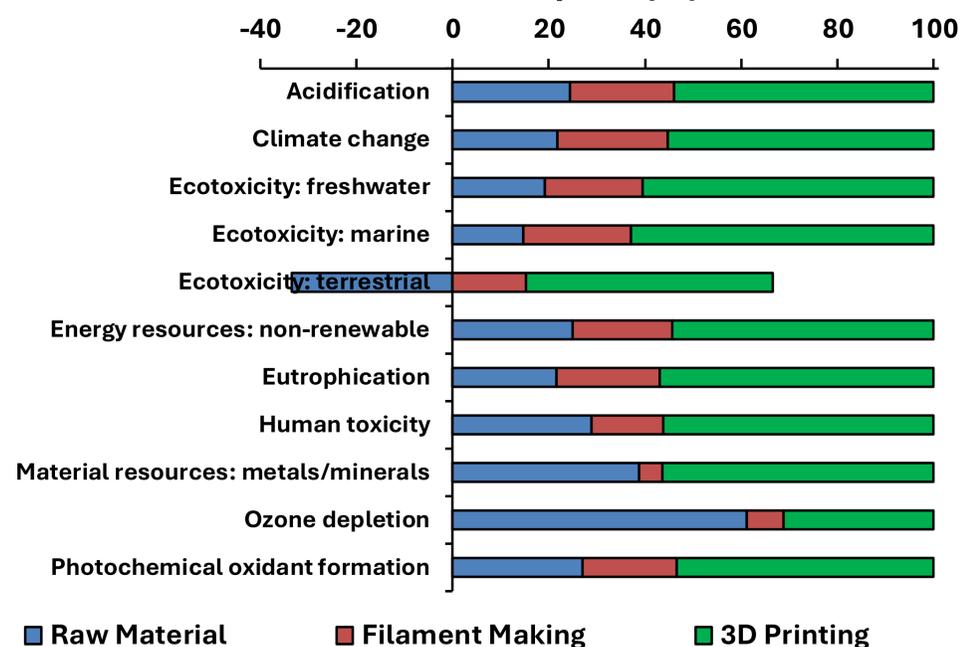
#### Impact Assessment Method

- ❖ Simulation Software: openLCA 2.6.0
- ❖ Database Used: Ecoinvent 3.11
- ❖ Energy Demand: CED Method
- ❖ Environmental Impact: CML v4.8

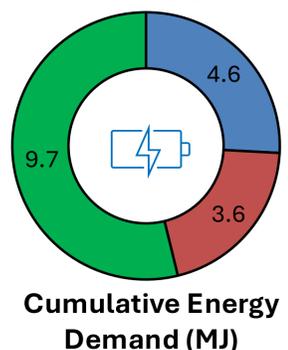


### RESULTS & DISCUSSION

#### Environmental Impact (%)



- ❖ The coir pith used as a reinforcing material is a by-product, and it shows low impact. Additionally, the bio-based raw materials used have the potential to enrich the terrestrial ecosystems.



- ❖ The significant use of electricity for 3D printing is responsible for more than 50% of the emissions potential across all impact categories except ozone depletion.
- ❖ The impact assessed for the bio-based raw materials derives mostly from the production of PLA. Acidification, eutrophication, ozone, etc. are associated with the agricultural step of corn that is the raw material for PLA.
- ❖ This emphasises the necessity of production of PLA from agricultural waste.

### CONCLUSION

- ❖ The significant emissions in all categories are from electricity usage as an energy source for filament extrusion and 3D printing.
- ❖ The use of bio-based material enriches the terrestrial ecosystem in contrast to its major contributor to ozone layer depletion.

### REFERENCES

1. Bi X, Huang R. 3D printing of natural fiber and composites: A state-of-the-art review. *Materials & Design* 2022;222:111065. <https://doi.org/10.1016/j.matdes.2022.111065>.
2. Operato L, Vitiello L, Aprea P, Ambrogi V, Salzano De Luna M, Filippone G. Life cycle assessment of poly(lactic acid)-based green composites filled with pine needles or kenaf fibers. *Journal of Cleaner Production* 2023;387:135901. <https://doi.org/10.1016/j.jclepro.2023.135901>.

### ACKNOWLEDGEMENTS

- ❖ The support received from the IoE Grant, IIT Madras, Govt of India and NTTM Project are acknowledged.