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Life Cycle Assessment of Fiber-Reinforced Additive Manufacturing for Injection Molding Insert Production

Thomas Hofstätter*[1], Philippe M Stotz[2], Niki Bey[2], David B Pedersen[1], Guido Tosello[1], Hans N Hansen[1]

1: Technical University of Denmark, Department of Mechanical Engineering
2: Technical University of Denmark, Department of Management Engineering
*Corresponding author email: thohofs@mek.dtu.dk

Additively manufactured (AM) injection molding (IM) inserts have proved to be capable to substitute conventionally manufactured metal inserts with polymer-based insert enforced with short, virgin, unseized carbon fibers (CFs). It has been shown that the implementation of AM technology resulted in significant improvements when investigating costs and cycle time for smaller part series. However, being a novel technology, AM inserts yield undesired characteristics, e.g. in terms of potential environmental impact because of the lower lifetime compared to metal inserts. Based on physical performance tests, this contribution provides a comparison of environmental performance of conventionally vs. additively manufactured inserts in a full life cycle perspective indicated in Figure 1, including materials, production, use and end-of-life (EoL) stages.

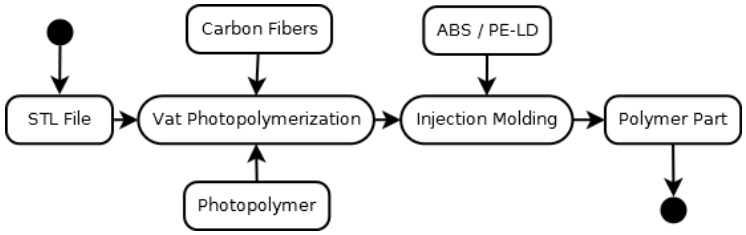

Figure 1 Overall process cycle with inputs and outputs.

The results indicate that the environmental impact of the AM inserts primarily depends on the AM process rather than the production of the photopolymer. As the AM insert is incinerated during the EoL, it does not receive the same credit as the metal insert, which is fully recycled. At low shot numbers (2500 approx.), the metal inserts show a higher impact in some categories (human toxicity non-cancer, freshwater ecotoxicity), but lose out on the global warming potential and human toxicity (cancer). At higher shot numbers, where multiple AM inserts are required to fulfil the function, it is outperformed by the metal insert in every impact category. In a holistic approach, AM can be expected to preferable in terms of time, cost, and flexibility.

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