1-Aug-2021  
  
Dear Dr. CAROU:

Manuscript ID JEM-21-0255 entitled "Feasibility study on the use of recycling materials for prototyping purposes: a comparative study based on the mechanical resistance" which you submitted to Journal of Engineering Manufacture, has been reviewed.  The comments of the reviewer(s) are included at the bottom of this letter.

The reviewer(s) have recommended major revisions to your manuscript. Therefore, I invite you to respond to the reviewer(s)' comments and revise your manuscript. May I also draw your attention to the attached Editorial Checklist as the issues should also be addressed when preparing for submission of your amended version.

To revise your manuscript, log into <https://mc.manuscriptcentral.com/joem> and enter your Author Center, where you will find your manuscript title listed under "Manuscripts with Decisions."  Under "Actions," click on "Create a Revision."  Your manuscript number has been appended to denote a revision. You may also click the below link to start the revision process:

\*\*\* PLEASE NOTE: This is a two-step process. After clicking on the link, you will be directed to a webpage to confirm.

<https://mc.manuscriptcentral.com/joem?URL_MASK=61549428037546ccbaccd3fe15f9653f>  
  
When submitting your revised manuscript, please respond to the comments made by the reviewer(s) in the space provided.  You can use this space to document any changes you make to the original manuscript.  In order to expedite the processing of the revised manuscript, please be as specific as possible in your response to the reviewer(s). Please also highlight the changes to your manuscript within the document by using bold or coloured text.

IMPORTANT:  Your original files are available to you when you upload your revised manuscript.  Please delete any redundant files before completing the submission.

Because we are trying to facilitate timely publication of manuscripts submitted to Journal of Engineering Manufacture, your revised manuscript should be uploaded within 6-8 weeks.  If it is not possible for you to submit your revision in a reasonable amount of time, we may have to consider your paper as a new submission.

Please note that resubmission of a revised manuscript does not guarantee acceptance.  Any revised manuscripts will be subject to the same rigorous, independent, peer review as any original version of the same manuscript.

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Before submitting your revision please check for any misspellings or other errors in the author list. Please note that if there are any changes in the order or number of authors at this stage all authors will be required to complete and sign a form authorising the change.

Failure to provide all permissions and/or sufficient explanation for any changes to authorship may delay publication of your manuscript.

Once again, thank you for submitting your manuscript to Journal of Engineering Manufacture and I look forward to receiving your revision.

Sincerely,  
Ms. Annapurna Gupta,

Associate Editor

The Journal of Engineering Manufacture Editorial Office

ANSWER TO REVIEWERS

We would like to thank all reviewers because of the time expend with our paper and for their insightful comments. We are coming up with a new draft in which we are considering these comments. Moreover, we have edited the manuscript aided by professional services that may help us improving its quality. We are answering all the comments below. Moreover, you can see all main changes highlighted in red in the manuscript (English changes are not highlighted).

Reviewer(s)' Comments to Author:

Reviewer: 1

Comments to the Author

The authors presented feasibility study on the use of recycled materials for prototyping purposes. The paper has original content and worthy for publication in the journal. I can recommend it for a possible publication. However, following comments must be considered carefully before this recommendation.

- Supply research highlights.

Thanks for requesting it. We are including the highlights in this new version.  
  
- In introduction section, clearly describe the relevance of the study to the journal's scope.

We thank you for the comment and we agree on that. One core elements of the Journal’s scope relies on the development of engineering manufacturing aspects. Given the increased interest in additive manufacturing as important driver for industry, among the diverse research paths currently studied, our proposition is focused in the topic of sustainable and clean manufacturing (scope) that we consider interesting for the journal. The main vision is the technical viability of recycled materials as substitutes for conventional virgin materials, which we hope engineers and designers can develop technology affordance to use materials in a sustainable manner. There are several parts of the text clearly related to the journal’s scope. For instance, this one related to additive manufacturing:

***Fused filament fabrication (FFF) is a major additive manufacturing (also called 3D printing) technology, which have found considerable number of applications in different types of manufacturing sectors.***[***1***](#ref-Singh2020d)

Besides, we have added some words in the following to refer to sustainable and clean manufacturing that we consider interesting for the paper:

***Nowadays, there is a need to find ways to reduce the ecological impact of manufacturing processes, pursuing sustainable and clean manufacturing processes.***[***4***](#ref-Niaki2019)***,***[***5***](#ref-Peng2018)

Finally, we are including “digital manufacturing” as a keyword in this new   
  
- The contribution of the research to the relevant literature should be defined in a better way.

We thank you for the comment. Given your comments, we re-structure the whole part of the background to include in the introduction section to be more focused in the proposition. We consider that our approach and results are discussed in the text against the current literature in parts like the following:

***While a large body of literature is focused on the optimization of the parameters for obtaining functional printed objects using 100 % of the printed material, the approach taken here is to observe the influence of a wide range of factors that are critical within conventional printing ranges. This type of approach enables designers and users to utilize printing setups that are designed for object prototypes, providing certainty about the quality of the printed products.***

Moreover, in the conclusions, we have added some words that strength one of the key points that is the analysis of the printing conclusions:

***The present study proposes a comprehensive experimental program to analyze the Fused Filament Fabrication process based on the tensile strength using virgin PLA and recycled PLA. The paper aims to improve the sustainability of the 3D printing process, proposing a methodology based on Design of Experiments approach in order to assess the technical feasibility of the substitution of recycled filaments for virgin ones by means of a better knowledge on the influence of the printing conditions. The final purpose in the long term is to recognize the technology affordance of prototyping side of additive manufacturing as a design tool to better ensure consumer acceptance and less waste 55.***

- Present the figures with larger fonts.

The figures were changed with the purpose to improve the readability. We hope that the changes are satisfactory for the reader.

- Kindly provide some recommendations for future studies in conclusion section.

Thanks for the comment. We consider that this is discussed in the “Discussion and limits of the results” section. Please, see the following text:

***There are certain limitations to this work in the perspective of materials and parameters tested. Certainly, the use of other materials is needed to confirm the main findings. Moreover, other factors are needed in order to consider the quality of a prototype. Clearly, other variables, such as aesthetic design, dimensional accuracy and surface quality***[***5***](#ref-Jin2017)***4 are also key variables to include for the printed objects in addition to the mechanical properties in the prototypes where the main goal is user acceptability.***[***5***](#ref-Sauer2009)***5,***[***5***](#ref-Sauer2010)***6***

Additionaly, in the conclusions section we added some lines of future research of certain elements that consider meaningful to study

***Future research needs to evaluate the quality of a (recycled) prototype including quality aspects other than tensile aspects such as aesthetics, accuracy. Moreover, the acceptability of recycled products that can be technical printable is a major milestone..***

- I also recommend editing your paper according to the instructions for authors in the journal website.

Thanks for this comment. We are doing that in this new version.

Reviewer: 2

Comments to the Author

Recycling concepts have been already discussed by many authors.

Novelty is not seen in the workFollowing are similar works on the above topic

<https://doi.org/10.1016/j.jclepro.2020.121602>  
<https://doi.org/10.1007/s11356-020-10657-8>  
<http://dx.doi.org/10.1089/3dp.2016.0054>

Thanks for the comments. Certainly, in the recent years, there have been great efforts in recycling direction as showed by the first review in the Journal of Cleaner Production that you stated. One of the authors of the present proposition worked likewise in the review. In fact, one motivation of our proposition is based on the results of this review because authors recognized that most of the literature focused only to validate the printable material in having in the mindset the object fully printed. And it is recognized that one of the major advances in the AM field is to able to control the quantity of material deposited in the final piece. The less material the better, until the limit of a usable resistance. Therefore, we agree that some works on the use of recycled materials in 3D printing have been recently published. However, we considered that the knowledge on this field is still in construction in order to change the mindset (hopefully) of engineers and designers about the use of recycling material in their practices of prototyping. We are contributing to the issue with a comprehensive experimental study focused on printing conditions. Please, consider that the first two references that you are kindly providing us are review studies that we included in our proposition and in the third one, which is an interesting experimental study, all samples were printed using the same printing conditions.

We think that our paper can contribute to consolidate knowledge and providing insights for using recycled materials, particularly in rapid prototyping applications, improving performance by means of adjusting the setting.

Reviewer: 3

Comments to the Author

(There are no comments.)

Thanks for your time.

Reviewer: 4

Comments to the Author

Hello dear authors,

The work sounds very interesting, but there are many similar works on virgin PLA and recycled PLA such as below, so the paper cannot be accepted for publication in the journal of Engineering manufacture.

A comparison between mechanical properties of specimens 3D printed with virgin and recycled PLA

3D printing goes greener: Study of the properties of post-consumer recycled polymers for the manufacturing of engineering components

On Process Capability of Multi Stage Primary and Secondary Recycled PLA Composite Matrix for 3D Printing Applications

Regards,

Thanks for your time and your comments. We are totally aware of the articles that you state. And, we agree with the reviewer that there are great efforts dealing with recycled materials and 3D printing as reviewer 2 also indicated. We would like to point out that the knowledge on this field is still in construction in term of the validation of the use of materials, but above all, the acceptability of recycled printed products as final output. This would imply that the use recycled plastics could be seen as ‘technological nutrient’ for possible cascade uses, extending the short life cycle of some plastics. This in line also with the European directive of the Circular Economy with the creation of secondary raw materials strategy, as stated in our discussion. Thus, the main rationale for us relies in the technology affordance of AM for sustainability, which it means the technology potential that comes from a goal-oriented behaviour and that turns into concrete actions. In the long term, we seek persuade the mindset of engineers and designers to see usability of recycled material for their prototyping practices. The literature validate the usability of recycled materials is a first major step. But we think it is not enough. We are contributing to the issue with a comprehensive experimental study focused on printing conditions. We developed a three phases program that allowed us to evaluate the most important printing factors: infill density, infill pattern, layer height, printing speed and printing orientation with a “limited” number of experiments: 56. We think that our paper can contribute to consolidate knowledge and providing insights for using recycled materials, particularly in rapid prototyping applications.

Reviewer: 5

Comments to the Author

Authors have done appreciable work; however the following points should be addressed –

•        Phase III study should be included in the Phase I study by incorporating ‘printing orientation’ as one of the process parameters. Please justify, why is Phase III study performed separately?

Firstly, we would like to explain that the three phases were done in this order. So, we did each phase, analysing the results and move to the next one. In this sense, in the first one we decided not to include the orientation when designing the experiment because the standard requires to perform 5 tests in each of the 3 orientations. This would result in 16\*15 specimens.

If we include Phase III into Phase I, we would be giving more weight to the printing conditions used in Phase III and the conclusions may be highly dependent on this decision. So, we think that Phase I is well designed as a screening phase, maintaining Phase III as a specific experimental study of the orientation.

We fully understand the point and we wanted to do it like the reviewer proposes from beginning on, but we couldn’t work with such many specimens to do it properly. Thanks for understanding it.

•        Please include names of process parameters and mention meaning of ‘\*\*’ and ‘\*\*\*’ in the Table 3.

Sure. Thanks a lot! We don’t what happened here. We are including the first column in the new version. Regarding the coding, we are not using that. These are the significance codes provided by R software. We are just using 0.95 and these symbols add little to our work. We changed the table to properly show the results. Additionally, we added the variable of Young modulus in the analysis of the results.

•        Page 7, Line 29 – It is written that ‘In the A region, infill … with an approximately linear.’ However, from the equation written in the Figure 4 (b), it is clear that the curves are represented by second order polynomial. Therefore, please make necessary corrections in the sentence.  
Also, please ensure similar changes on Page 9, Line 53 - ‘The influence of … : from 40 to 80%, linear behavior with a slight slope, and from 80 to 100 % … a greater extent.’

We thank you for your remarks, we change the figurean we hope that the point. The main idea that we like to state is that the infill density on the printed part it is not lineal in the whole range according to our results. A detailed analysis of , is beyond of the scope of our proposition. However, whzt it was interesting to know for us was the % of the resistance that the printed part support given the % of the infill density. This elements certainly is design question that engineers and designers could have during the prototyping phases.

•        From the study of Babagowda et al. it is observed that lower percentage of recycled PLA in the blend results in the higher ultimate tensile strength. However, in the present study, 90% recycled PLA is used in the blend. Please explain the reason behind the use of 90 % recycled PLA in the blend.

We use that work as reference. In our case, our percentage was established by the manufacturer. We worked with a commercial recycled PLA.

•        Investigation related to the maximum load attained after 2nd and 3rd recycling of PLA should be incorporated in the present study.

Unfortunately, we cannot go back to these experiments and conduct new research as the proposed. The tests were performed several months ago, and we consider that some degradation is likely to occur. Besides, as we commented before, our recycled filament was commercial, and we can’t obtain new filament by reprocessing our samples with the same extruding conditions.

Reviewer: 6

Comments to the Author

Please consider these comments for improving the paper quality:

-        Pag. 2: Details about the authors are missing.

Thanks for the comments and we are sorry for the inconvience. We have changed the manuscript as requested for the revision given the fact that the journal is single-blind.

-        Comma should be put after the reference number. See for instance pag 2-line 35-35-36-44 etc (..processes.4,5       …with users.11  etc etc).

Thanks for the remark. We are updating the reference style in order to meet the guidelines of the journal.

-        Table 1: Text font is too big.

We changed the font size in this table (and the rest). We think that in any case the editing services of the journal should solve some editing problems like this one.

-        Try to put Figure 2 closer to the text where it is cited, therefore before section 4.

We agree. We consolidate this new version in order to improve the readability of the text and the figures. We expecte that these changes facilitate the lecture.

-        Pag. 5-Line 28: “Based on the literature research presented in section 2, the critical parameters for the study are the (1) layer height (0.15 and 0.3 mm) and (2) infill pattern (tri-hexagonal and grid).” Add reference/s.

Thanks for the comment. We are including these references in the manuscript.

-        Pag. 5-Line 34: “(3) infill density -ID- and (4) printing speed -PS- were considered.40,41 These four factors were selected using two levels for each of them with large ranges. The printing temperature was 210 °C, which was the recommended for PLA material. This phase ends with an analysis of variance (ANOVA) to identify the influential factors on the response variable.” Maybe this part has to be merged with the previous sentence (it also has a different formatting). Please check.

- Thanks for the remark. Changes were made to improve the formatting aspect and the coherence. We hope that this responds to the reviewer’s concern.

-        Figure 3: Description of (a) and (b) should be reported in the figure caption directly (not next to (a) and (b)). Same comment for Figures 4 and 5.

We have change the figure caption to meet the standards of the journal. We thank for your comment

-        Pag. 8-Line 12: “..each of the factors. and the Table..” Remove the dot.

Thanks for that. Done!

-        Pag. 8-Line 30: The sentence is in bolt.

We’ve checked that the manuscript do not include bolt letters.   
-        Section 5 should highlight and discuss better the obtained results.

Major changes were made in the discussion section with the purpose to highlight the contribution of the article. We hope that these elements could improve the readability and the arguments given.

Reviewer: 7

Comments to the Author

Dear Author.

thank you for work on recycling

1. General review this paper needs more proof reads

Thank you for the advice. We have revised the manuscript and we improved it thanks to professional editing for this new version.

2. Page 2, line 17 existing theories and previous can be merged with introduction and literature

We followed the reviewer’s suggestion for a better and more targeted version of the manuscript. We merged the introduction and the background highlighting the goal and pertinence of our proposition. We were afraid to have a very large introduction section but we managed to propose a coherent and balanced proposition to readers. Thanks for the suggestion.

4. for tensile test how many sets were fabricated for each combination of parameters in all phases?.

Phase I: 16

Phase II: 10

Phase III: 30

Total: 56

In the text you can find details of the two first phase, but it’s true that we have not included the number of specimens in the third one. So, we are adding this text for clarifying phase III:

***A total of 30 samples were tested.***

Moreover, we believe that the pictures of the specimens are also helpful for readers.

5. page 5 table 2, please could you add young’s modulus data also?

As suggested by the reviewer, major changes were made in the proposition to include the young’s modulus in the analysis. We expected that these elements could add value to the proposition.

6. page 6. Figure 3.(a) sample no : RE 2 U, what kind of fracture ?

This is a case in which more research for sure is needed. In this case, in fact, there were no full fracture of the specimen. There were two starting points for fracture, creating two parallel lines, but in the middle some fibers seem to show high resistance to fracture. We think that we can’t go further without additional research, so we are describing the result like this:

***The breakage in these cases occurred at a 45****°* ***angle and, in the case of the RE-2 specimen, two parallel fracture lines can be clearly seen.***

Associate Editor's Comments to the Author:

Associate Editor

Comments to the Author:

Please revise the paper carefully. The use of the phase "mechanical résistance" in the abstract and paper does not seem to be correct. Please modify to the actual parameter evaluated in the study. Please correct the title as well.

Thanks for the comment. We agree on that and we removed all “mechanical resistance” in the text. We are using “Tensile strength” when referring to our results. When referring to general mechanical characteristics of the parts, we are using “mechanical properties”.   
Editor in Chief’s Comments to the Author:

The paper will benefit from a thorough proof-reading to improve the quality of English and enhance its readability. The use of professional proof-reading services is recommended.

We have revised the manuscript and use professional guidance in this new version. Thanks for your suggestion

The referencing needs strengthening and updating. In the process, the authors may wish to recognise the contribution of the Journal of Engineering Manufacture in the knowledge of this field of manufacturing by considering relevant papers, recently published in the Journal.

Certainly, and we have revised some of the references used in our background and highlight the relevance of the Journal of Engineering Manufacture in the field of additive manufacturing. Thanks for the suggestion.