FEASIBILITY STUDY OF THE USE OF A NEW BIODEGRADABLE MATERIAL AS A RAW MATERIAL IN INDUSTRIAL PROCESSES

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DOI: 10.56007/arrivet.v1i1.33

ABSTRACT:

The utilization of biodegradable materials in industrial procedures represents a strategic priority within the Basque Regional Specialization Strategies RIS3. This article presents the feasibility study in industrial processes of a sustainable material based on collagen, which is renewable, ecological and has a carbon footprint of practically zero. The material, called EKOMAT, patented by the company EKOLBER, has been tested at the CIFP MIguel Altuna centre in Bergara, Basque Country-Spain to check its applicability in 2 industrial processes. It is noteworthy that this project is part of the applied innovation activities carried out by teachers at the centre.

Keywords: biomaterial; VET centres; applied research; innovation

1. CONTEXTUALISATION AND METHODOLOGY

EKOLBER is a company founded in 2015, which emerged from the business incubator of CIFP Miguel Altuna (Miguel Altuna Lanbide Heziketa, n.d.), dedicated to the development of novel ecological materials derived from livestock industry waste and other types of biological waste.

One remarkable achievement is the formulation of EKOMAT (EKOLBER, n.d.), a sustainable biomaterial primarily constituted of renewable collagen. It stands as an ecological innovation, characterized by an almost negligible carbon footprint. EKOMAT is sourced directly from natural waste materials, including but not limited to skins, wool, feathers, and eggshells. This sustainable approach plays a pivotal role in mitigating the disposal of such materials into landfills, promoting ecological preservation.

Fig. 1 Biomaterial EKOMAT, suitable for biomedical or food applications. Source: EKOBER

Following the development of the material and its manufacturing procedures, EKOLBER initiated a feasibility investigation regarding the integration of its material into industrial processes. This comprehensive analysis encompassed the exploration of various manufacturing technologies, material specifications essential for compatibility with industrial processes, and the practical applicability of EKOMAT within these contexts. The study encompasses dual facets, addressing both the production of the material in a specific format and the stipulated specifications tailored for particular industrial procedures. It also delves into the functional attributes of the resulting manufactured products.

EKOLBER opted to collaborate with a Basque High Vocational Education and Training (HVET) center, CIPF Miguel Altuna, to conduct this feasibility assessment across two distinct manufacturing processes: the utilization of EKOMAT wires for 3D printing applications and the incorporation of EKOMAT material plates for the production of machined parts possessing requisite mechanical characteristics.

2. WORK CARRIED OUT

2.1 Line of work 1: collagen filament as a raw material in fdm technology 3D printers

The production phase of 1.75mm diameter filament spools was carried out by EKOLBER, while the piloting phase for this material was carried out by CIFP Miguel Altuna.

To evaluate the collagen coils, a series of pilot experiments were conducted using a 3D printer equipped with FDM technology, which stands for fused deposition modelling. These experiments aimed to fabricate diverse collagen wires utilizing the capabilities offered by the 3D printers. The pilot tests were specifically conducted using the Anycubic 4 max pro 2.0 printer. The parameters subjected to analysis encompassed various EKOMAT material grades, extruder diameter, extruder temperature, bed temperature, and printing speed.

2.2 Line of work 2: obtaining plates from EKOMAT material for machining on machine tools (milling machine, lathe).

The research conducted at CIFP Miguel Altuna commenced with the initial phases of designing and fabricating molds used in the production of various grades of EKOMAT material sheets. Subsequently, machinability tests were conducted on these produced sheets.

The working group of the centre was responsible for designing and manufacturing steel molds tailored for the injection of collagen, strictly adhering to the specified dimensions. Notably, two distinct qualities of EKOMAT injected material, designated as N1 and N2, were successfully manufactured.

The evaluation comprised two distinct testing phases, with the initial phase involving the examination of the N1 and N2 materials, yielding the following results.

Fig. 2 Pruebas realizadas con material EKOMAT N1 Fuente: CIFP Miguel Altuna

Fig. 3 Tests carried out with N2 material Source: CIFP Miguel Altuna

The study of the injection conditions prompted adjustments in the composition of the collagen material, resulting in the development of materials designated as CF15 CC100 and CF15 CC150. Subsequent testing of these newly formulated materials yielded favourable outcomes, thus paving the way for the subsequent phase of the machinability investigation.

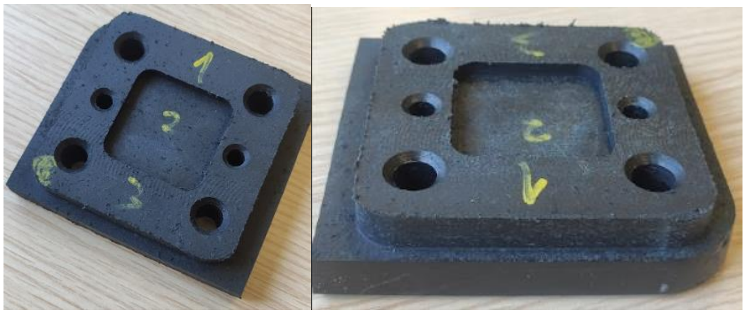

Fig. 4 Machinability tests carried out on CF15 CC100 and CF15 CC150 material. Source: CIFP Miguel Altuna

3. RESULTS

3.1 Results in 3d printing (line 1)

As of the time of composing this article, the 3D printing of components using EKOMAT material has not yet been realized. Present assessments indicate promising outcomes for future exploration:

- Very low temperature melting of the material has been achieved with larger extruder diameters.
- Challenges related to material creep have arisen due to non-uniform filament diameter along its entire length, prompting ongoing analysis for achieving consistency.
- Adaptations are required for the bed material to ensure strong adhesion of the initial printed layer.

Collagen material properties exhibit temporal variations, necessitating prompt utilization following material processing for conclusive findings. The analysis of the variation of properties of the tested materials is crucial, particularly concerning their constraining impact on industrial production processes.

Fig. 5 Printed plates. Source EKOLBER

3.2 Results of the machinability study (line 2)

The analysis of the machinability in milling machines reveals that the N1 and N2 materials are very soft for machining processes, leading to issues related to tool blunting. On the other hand, the CC150 material developed as a result of the first tests with N1 and N2 exhibits commendable machining characteristics. As areas for potential enhancement, the study underscores the necessity of fine-tuning machining parameters to achieve superior surface finishes.

Regarding the assessment of lathe machining, the initial materials employed demonstrated irregularities, necessitating the exploration of various clamping methods to ensure comprehensive examination. This phase of the investigation remains ongoing and is slated for conclusion by December 2023.

Fig. 6 Starting material for machinability tests on the lathe. Source: CIFP Miguel Altuna

3.3 Conclusions and outlook

In this project, teachers from CIFP Miguel Altuna have successfully conducted assessments of the production parameters for various grades of the biomaterial EKOMAT in two distinct manufacturing processes. One involves its utilization as filament material in additive manufacturing, while the other pertains to its application as raw material plates for subsequent machining operations.

In both scenarios, adjustments have been made to the parameters to align them with the specific requirements of each process, particularly in the case of materials intended for machining.

It is noteworthy that further experimentation is deemed necessary to enhance the outcomes achieved thus far in both contexts.

Ultimately, this project holds significant importance for CIFP Miguel Altuna, given its alignment with the 2030 Sustainable Development Goals (SDGs). The contribution towards the development of sustainable materials for industrial applications aligns seamlessly with the center's sustainability strategy, fostering a transition toward an environmentally sustainable institution in its daily operations and educational offerings.

4. REFERENCES

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