Acta Tecnología - International Scientific Journal about Technologies
Volume: 8 2022 Issue: 2 Pages: 67-70 ISSN 2453-675X



*doi:10.22306/atec.v8i2.150* *Received: 10 May 2022; Revised: 25 May 2022; Accepted: 12 Jun. 2022*

# PROPOSAL FOR OPTIMIZATION OF BIOMEDICAL FILAMENT PRODUCTION

**Tomáš Balint**
Biomedical engineering and measurement department, Faculty of mechanical engineering, Technical University of Košice, Letná 9, 042 00,
tomas.balint@tuke.sk (corresponding author)
**Jozef Živčák**
Biomedical engineering and measurement department, Faculty of mechanical engineering, Technical University of Košice, Letná 9, 042 00,
jozef.zivcak@tuke.sk
**Norbert Ferenčík**
Biomedical engineering and measurement department, Faculty of mechanical engineering, Technical University of Košice, Letná 9, 042 00,
norbert.ferencik@tuke.sk
**Alena Findrik Balogová**
Biomedical engineering and measurement department, Faculty of mechanical engineering, Technical University of Košice, Letná 9, 042 00,
alena.findrik.balogova@tuke.sk
**Samuel Lancoš**
Biomedical engineering and measurement department, Faculty of mechanical engineering, Technical University of Košice, Letná 9, 042 00,
samuel.lancos@tuke.sk
**Miroslav Kohan**
Biomedical engineering and measurement department, Faculty of mechanical engineering, Technical University of Košice, Letná 9, 042 00,
miroslav.kohan@tuke.sk

***Keywords:*** Laminar box, filament, filament maker, extrusion.
***Abstract:*** Filament production is a demanding process, which we decided to optimize by designing a laminar box in this scientific study. From a number of designs, we decided to choose a purposeful design for the future construction of the laminar box. The production of filaments takes place on a filament maker, which must be placed in a laminar box. The laminar box then provides ideal conditions in the production process, such as the optimum ambient temperature, which according to standards should be in the range of 18 to 19 degrees Celsius. Furthermore, this laminar box is equipped with a thermometer, hygrometer and control unit. All technical specifications are written in this scientific study. The study contains a number of illustrations for a better idea. The laminar box represents a significant contribution to the production and optimization of the conditions for the production of biomedical filaments. His design is unique and follows from the scientific research of the authors of the scientific study.

## 1 Introduction

The production of filaments can also be characterized as a several-step process (figure 1) from obtaining the material in the form of pellets through drying and extrusion of the filament itself on a filament maker.

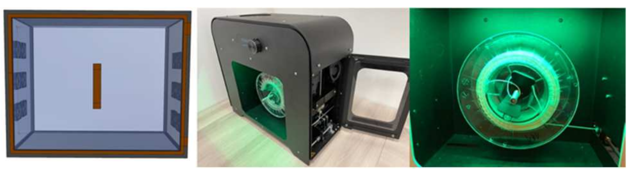

*Figure 1 Optimized production process*

The laminar box can be also defined as a laboratory station designed to work in dust-free, sterile conditions. The use of laminar boxes is broad-spectrum. Laminar boxes are mainly used in applications of optical, laser, semiconductor and electronic technologies. The design of the laminar box is designed to prevent contact with the external environment and thus ensure the protection of researchers as well as the researched material. Most laminar boxes are equipped with a HEPA filter, through which air is sucked in and blown out by a very smooth, laminar flow towards the user outwards. Another important function is to ensure the protection of the product (workspace) against particles. The picture shows a laminar box, which is equipped with two filters, a fan, an air intake



Copyright © Acta Tecnología, www.actatecnologia.eu

and an air extraction opening. The construction of this laminar box is simple and practical with transparent walls.

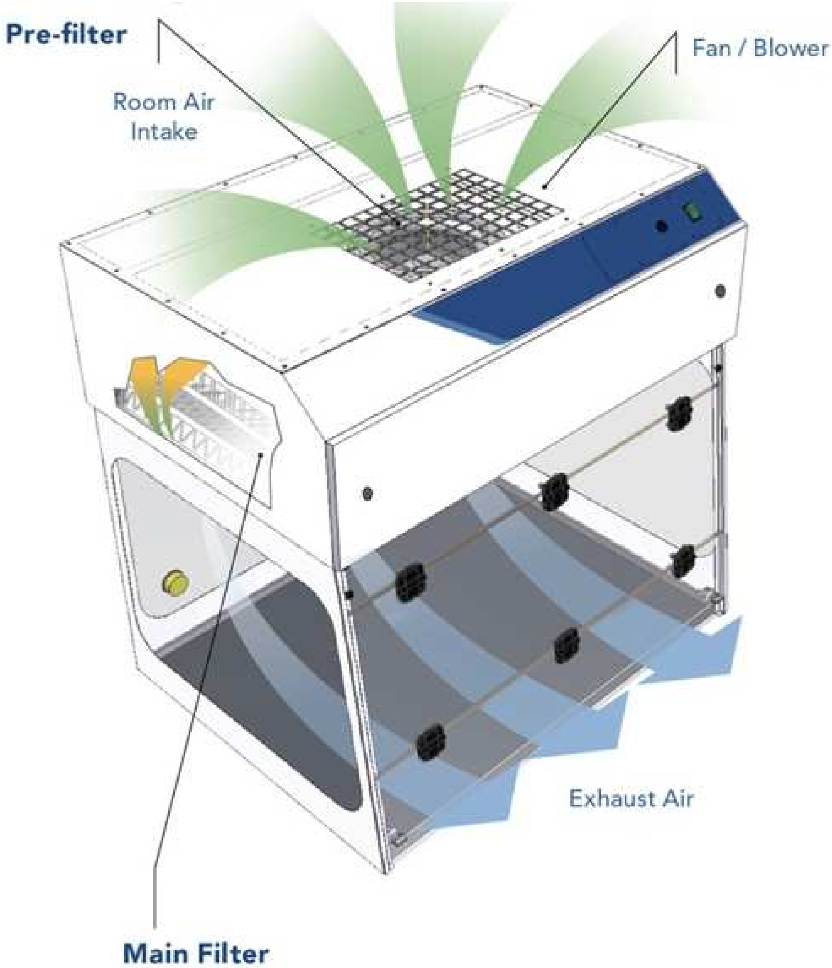


*Figure 2 Laminar box [1]*

Laminar boxes can be equipped with UV light, which has the task of sterilizing the working environment of the laminar box. The unit with UV light is equipped with a timer and a sensor that prevents exposure to UV radiation when lifting the door [1-6].

### *1.1 Laminar box design*

As part of improving the quality of biomedical filament production, we at the Department of Biomedical Engineering and Measurement proceeded to our own design of a laminar box called Biomedic laminar box. We made the model of the laminar box in the 3D modeling program SketchUp, the interface of which can be seen in the picture. The laminar itself stands out with its simple and practical design (figure 3a and figure 3b). The compact dimensions ensure trouble-free handling when operating the filament maker in the production process. The sterile environment is ensured by insulation. It is made of aluminum profiles and plexiglass with a thorough connection. Air recovery in the laminar box is ensured by twelve fans, which supply and discharge air.

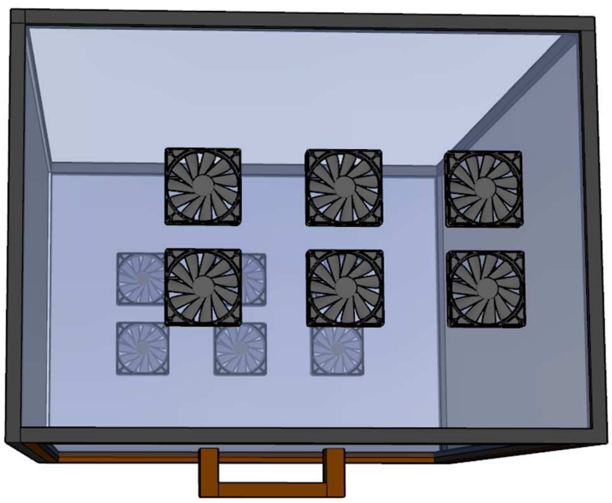

*Figure 3a Laminar box design*



Copyright © Acta Tecnología, www.actatecnologia.eu

Acta Tecnología - International Scientific Journal about Technologies
Volume: 8 2022 Issue: 2 Pages: 67-70 ISSN 2453-675X



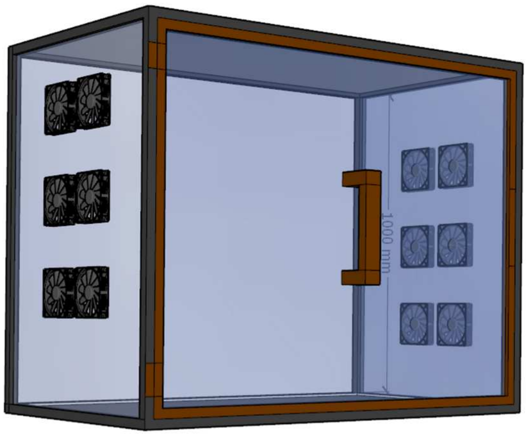


*Figure 3b Laminar box design*

The interface of the 3D modeling program SketchUp perfectly fulfilled its purpose in the design of this unique laminar box.

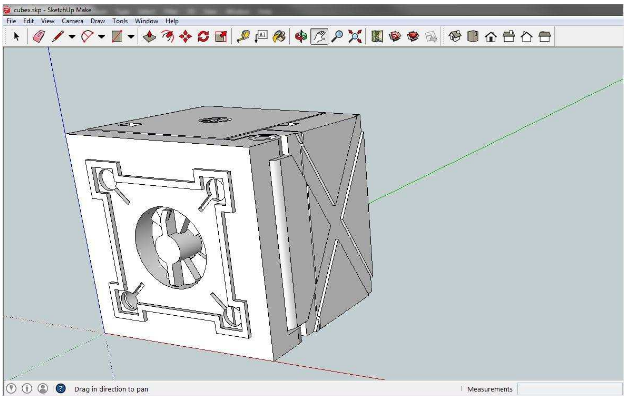

*Figure 4 3D modeling program interface*

The laminar box is equipped with a thermometer, hygrometer and control unit. Control is provided via the open-source Adruino UNO platform and the Adruino IDE program via a computer. The platform is located in an electrical protection chamber attached to the wall of the laminar box. The side view of the Biomedic laminar box shows (figure 5). This laminar box design serves as a theoretical basis for real construction and optimization of conditions for the production of biomedical filaments.

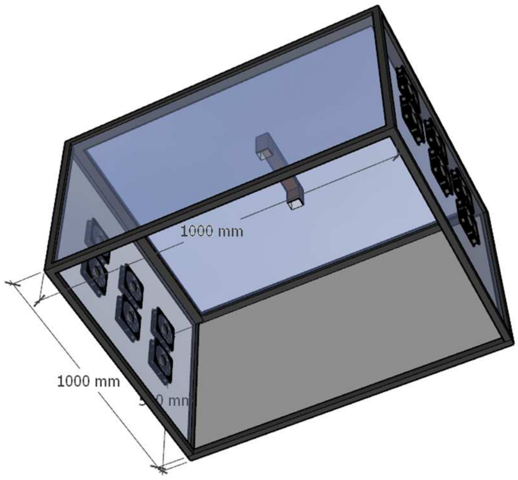


*Figure 5 A side view*

The table 1 shows more detailed technical specifications and dimensions of the laminar box.

*Table 1 Technical specifications*

| Designation of laminar box | Biomedic laminar box |
|---|---|
| Width | **1000 (mm)** |
| Height | **1000 (mm)** |
| Depth | **500 (mm)** |
| Air inlet | **With 6 power fans** |
| Air outlet | **With 6 power fans** |
| Optimum working environment temperature | **18-19°C** |

## 2 Conclusions

This scientific study has a contribution in the field of material extrusion and provides a theoretical design with real solutions for the construction of a laminar box. At the end of this study, the authors point out the continuation of research. Filament production is gaining more and more prominence. Therefore, the production conditions cannot be neglected. The future of the use of filaments lies in the production of biocompatible implants through additive technology. The study describes technical specifications that indicate success in the production and use of laminar box.

**Acknowledgement**
This scientific study was created thanks to support under the Operational Program Integrated In-frastructure for the project "Center for Medical Bioadditive Research and Production (CEMBAM), code ITMS2014 +: 313011V358, co-financed by the European Regional Development Fund", with the support of the projects KEGA 044TUKE-4/2022 and KEGA 023TUKE-4/2020 with the support of the project VEGA 1/0599/22. This publication was created thanks to support under the Op-erational Program Integrated Infrastructure for the project: Open Scientific Community for Mod-ern Interdisciplinary Research in



Copyright © Acta Tecnología, www.actatecnologia.eu

Medicine (OPENMED), code ITMS2014 +: 313011V455, co-financed by the European Regional Development Fund and thanks to support under the Opera-tional Program Integrated infrastructure for the project: Center for Advanced Therapies of Chronic Inflammatory Diseases of the Musculoskeletal System (CPT ZOPA), code ITMS2014 +: 313011W410, co-financed by the European Regional Development Fund.

## References

[1] ZEERATKAR, M., DE TULIO, M., PERCOCO, G.: Fused Filament Fabrication (FFF) for Manufacturing of Microfluidic Micromixers: An Experimental Study on the Effect of Process Variables in Printed Microfluidic Micromixers, *Micromachines*, Vol. 12, No. 8, pp. 1-13, 2021. https://doi.org/10.3390/mi12080858

[2] HASEGAWA, K., MATSUMOTO, M., HOSOKAWA, K., MAEDA, M.: Detection of methylated DNA on a power-free microfluidic chip with laminar flow-assisted dendritic amplification, *Analytical Sciences*, Vol. 32, No. 6, pp. 603-606, 2016. https://doi.org/10.2116/analsci.32.603

[3] OU, J., MOSS, G.R., ROTHSTEIN, J.P.: Enhanced mixing in laminar flows using ultrahydrophobic surfaces, *Physical Review E*, Vol. 76, No. 1, pp. 1-10, 2007.

[4] AGHAEI ARAEI, A., TOWHATA, I.: Impact and cyclic shaking on loose sand properties in laminar box using gap sensors, *Soil Dynamics and Earthquake Engineering*, Vol. 66, No. November, pp. 401-414, 2014.

[5] UENG, T.S., CHEN, CH., PENG, L.H., LI, W.C.: *Large-scale shear box soil liquefaction testing on shaking table (III) – preparation of large sand specimen and preliminary shaking table test*, In: Proceedings of the National Center for Research on Earthquake Engineering, Taiwan, 2006.

[6] KHABBAZIAN, M., KALIAKIN, V.N., MEEHAN, C.L.: Numerical study of the effect of geosynthetic encasement on the behaviour of granular columns, *Geosynthetics International*, Vol. 17, No. 3, pp. 132-143, 2010.

**Review process**
Single-blind peer review process.



Copyright © Acta Tecnología, www.actatecnologia.eu