УДК 621.7-023.5

T.Rudnytska

A.Litvin

P.Kuzmenko

METAL 3D PRINTING AS A PROMISING TECHNOLOGY IN MECHANICAL ENGINEERING

Vinnytsia National Technical University

Анотація: *У статті розглядються переваги металевого 3D-друку як сучасної інженерної технології. Пропонується практичні методи застосування металів, які використовуються у виробництві.*

Ключові слова: *3d друк металу, адитивне виробництво, селективне лазерне плавлення, пряме лазерне спікання металу, верстат.*

Abstract: *The article considers the advantages of metal 3D printing as a contemporary engineering technology. The top applications and common metals used in manufacturing are suggested.*

Keywords: *Metal 3d printing, additive manufacturing, selective laser melting, direct metal laser sintering, machine tool.*

Introduction

In contemporary engineering metal 3D printing stands out as a transformative force in manufacturing, particularly in the field of mechanical engineering. This cutting-edge technology, often referred to as additive manufacturing has surged forward, offering unprecedented opportunities for innovation and efficiency in the production of complex metal components.

Statement of Basic Materials

Metal powder is the backbone of metal 3D printing. Though it's difficult and dangerous to handle in its raw state, its unique features make it the preferred metal stock type. The vast majority of metal 3D printing technologies utilize metal powder. As a result, the major differences between types of metal printers relate to how they fuse the powder into metal parts. These methods vary greatly, ranging from using high energy lasers to fuse loose powder to extruding bound metal powder filament.

Many specialists consider metal powder bed fusion 3D printing (SLS, SLM, DMP) as the most beneficial technology in mechanical engineering. Powder 3D printing systems fall under the categories of powder bed fusion or powder bed additive manufacture. These methods utilize either an electron beam, laser, or heat to liquefy and bond metal particles. Selective laser sintering ,selective laser melting , and direct metal printing, also known as direct metal laser sintering, are common processes in metal 3D printing. In PBF, powdered metal is evenly distributed onto a build platform and smoothed out using a roller or recoater blade. A laser is then directed across the build area, melting the powdered metal. The build platform descends by the layer thickness, and the process repeats until all layers are printed.

Table 1 Metal Powder Bed Fusion Pros and Cons

Pros	Cons
Intrinsic support from the powder bed, no supports required	Some manufacturers offer a limited range of material compositions
Smooth surfaces direct from the printer	Requires high-quality, expensive lasers
20 μm minimum layer thickness, commonly 35–50 μm	Some systems offer relatively slow build
Builds more-porous parts	High residual stresses result from unstable melt pools

The top applications of metal 3D printing include low-volume and specialty parts, functional metal prototypes, spare and obsolete parts, factory tooling, surgical and dental implants, jewelry and decorative arts, orthopedic lightweight implants.

Picture 1 - A new type of orthopedic lightweight implants using metal 3D printing.

As for the metals used in 3D printing the technology doesn't always require unique metals. Various machines and technologies can utilize the same metal materials found in traditional manufacturing processes like injection molding or welding. Nonetheless, certain 3D printing methods excel when using metals, especially powders designed specifically for this purpose. some metals, particularly reactive or reflective ones like copper, necessitate specialized 3D printers with specific features tailored to handle these materials.The most common metals used in 3D printing are stainless steel, titanium, aluminum, copper, tool steel.

Among the advantages of metal 3D printing there could be distinguished :

1. The ability to design geometrically complex parts. In metal 3D printing complexity is free. Unlike conventional manufacturing, additive manufacturing is cost-independent from part complexity. Compared to subtractive CNC machines, it’s more adept at curved, natural shapes and intricate geometries. As a result, complex parts are cheaper, easier, and faster to produce with a metal 3D printer.

2. The ability to manufacture parts without tooling. Many traditionally manufactured parts require custom tooling and fixtures. These parts, while critical to the manufacturing process, occupy manufacturing bandwidth without generating revenue. For low volume production parts in particular, tooling costs can make fabrication cost-prohibitive. No custom tooling or fixturing setups are needed to run a metal 3D printer, regardless of the parts printed. This reduces overhead costs associated with manufacturing and produces low-volume parts more quickly and affordably.

3. The ability to produce parts without detail drawings or CAM. Machined parts require drawings, CAM, or both — 3D printed metal parts do not. Metal 3D printing software automatically generates and executes the tool paths required to build the part. Instead of generating drawings and programming CAM, all manufacturers have to do is orient a part and select materials and basic print settings.

Conclusion

3D printing in metal is a promising manufacturing direction that is gaining increasing importance in various industries, including aviation, automotive, medical, manufacturing, and others. It is an innovative technology that opens up new opportunities for rapid and efficient production of complex metal parts and structures with high precision and quality.

REFERENCES

1. https://markforged.com/resources/learn/design-for-additive-manufacturing-metals/metal-additive-manufacturing-introduction/types-of-3d-printing-metal
2. https://all3dp.com/1/metal-3d-printing-ultimate-guide/
3. https://www.xometry.com/resources/3d-printing/types-of-metal-3d-printing/
4. https://markforged.com/resources/blog/back-to-basics-benefits-of-metal-3d-printing

Рудницька Тетяна Григорівна – старший викладач кафедри іноземних мов, Вінницький національний технічний університет, e-mail: rudnytska@vntu.edu.ua

Літвін Артур Миколайович - студент групи 1ПМ-22б, Факультет машинобудування та транспорту, Вінницький національний технічний університет, м. Вінниця, e-mail: litvinartur123@gmail.com

Кузьменко Поліна Андріївна - студент групи 1ПМ-22б, Факультет машинобудування та транспорту, Вінницький національний технічний університет, м. Вінниця, e-mail: polinakuzmenko60@gmail.com

Rudnytska Tetiana Hryhorivna – an Assistant Professor of Foreign Languages Department, Vinnytsia National Technical University, e-mail: rudnytska@vntu.edu.ua

Litvin Artur Mycolayovich– student of group 1ПМ-22Б, Faculty of Mechanical Engineering and Transport,, Vinnytsia National Technical University, Vinnytsia. e-mail: litvinartur123@gmail.com

Polina Andryivna Kuzmenko– student of group 1ПМ-22Б, Faculty of Mechanical Engineering and Transport, Vinnytsia National Technical University, Vinnytsia. e-mail: polinakuzmenko60@gmail.com