Steel frames made by 3D printing

Abstract

Today, material scientists are faced with the task of developing material-saving and energy-saving technologies for metallurgy. One of the most material- and energy-saving technologies is 3D printing.

My research is devoted to finding ways to increase the strength of products made by 3D printing.

I decided to make research and mathematical modeling. Mechanical characteristics of the samples with elementary shape of a square cell are 2 to 9 times lower than the characteristics of foundry materials.

The results of mathematical modeling give me reason to believe that printing steel 3D frames with cells in the shape of hexagons with four or five diagonals and using two lasers in a 3D printer will create designs with mechanical properties that are close to the properties of cast steel products.

Keyword: 3D printing, elementary cell, mechanical properties.

Introduction

Today, material scientists are faced with the task of developing material-saving and energy-saving technologies for metallurgy. One of the most material- and energy-saving technologies is 3D printing. My research is devoted to finding ways to increase the strength of products made by 3D printing.

In the laboratories of the Kyiv Polytechnic Institute, with the help of scientists, I made several samples of 3D iron lattice. The elementary cell of the lattice of the samples had the shape of a square. I conducted a study of the structure and mechanical characteristics of the samples. The structure of the material of the studied samples is granular-fibrous. Mechanical characteristics are 2 to 9 times lower than the characteristics of foundry materials.

Scientists suggest the following ways to strengthen the 3D lattice: the use of two lasers in 3D printing or impregnation of the lattice with another material, such as aluminum. I believe that the mechanical properties of the product can be improved by increasing the rigidity of the lattice itself. Therefore, I propose to use the shape of an elementary cell: a regular hexagon, a hexagon consisting of 3 rhombuses and a hexagon with 4 or 5 diagonals.

Methodology

In our research we used: 3D printer “Realized SLM50”, microscope “SELM-106”, universal machine “CERAMTEST”, pendulum copro “KM-5”. Also we made mathematical modeling.

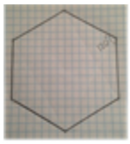
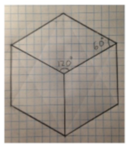
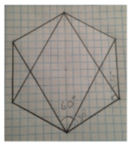
Recommendation

My researches can help people to will allow to receive rather strong material with porosity of 75-85% and reduce waste of materials and energy in 3-4 times in comparison with production of cast materials.

Results and conclusion

Mechanical characteristics	3D steel frames	Casting block
Elasticity modulus	23,9	200
Yield limit σ_{02}, Mp	42	160
Strength limit under compression $_{ст}$, Mp	90	170
Impact viscosity KCV, y/m^2	23	z98

Comparative chart of mechanical characteristics of porous 3D iron frames and solid steel materials.

Geometric shapes of 3D grid of elementary cell				
Dissipation the action of initial strength in the fifth layer of a 3D lattice	Practically not dissipated	Dissipates by approximately 2 times	Dissipates by approximately 16 times	Dissipates by approximately 24 times

The table show dissipation the action of initial strength in the fifth layer of a 3D lattice

Conclusion

The results of mathematical modeling give me reason to believe that printing steel 3D frames with cells in the shape of hexagons with four or five diagonals and using two lasers in a 3D printer will create designs with mechanical properties that are close to the properties of cast steel products.

3D printing of a lattice with cells in the form of hexagons with four and five diagonals will allow to receive rather strong material with porosity of 75-85% and reduce waste of materials and energy in 3-4 times in comparison with production of cast materials.

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