Optimization of microstructure design of powder alloys for additive technologies

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Abstract

Statement of the problem

Additive Manufacturing (AM) opens up broad prospects for the production of products of any shape and size from a variety of structural materials such as: polymers, concretes, ceramics, composites and powders based on pure metals and special alloys. Serious problem is the porosity of the finished product, which is difficult to avoid during 3D printing. This can cause a deterioration in the mechanical properties of the final product. In addition, we are not aware of studies the impact on the properties of other microstructure defects, such as local formation of surface microdendrites on powder particles, or the formation of agglomerates from fine-dispersed fractions of powder, or have not evaluated the features of the internal structure and phase state of individual powder particles in cross-section.

Without physical-mathematical and computer simulation methods, it is impossible to effectively optimize the microstructure and technological parameters of 3D printing of quality and durable products. The application of numerical modeling will allow for effective prediction of the results of «knapsack packing» with a combination of powder particles of different form and fractional compositions. This will contribute not only to the improvement of the additive manufacturing process, but also to the improvement of metal powder manufacturing technologies and the optimization of their properties.

Conclusion & Significance: As a result of conducted research is to optimize the design of the microstructure of powder alloys of various fractional compositions with expected mechanical, functional, and technological properties using physical-mathematical models.

Image

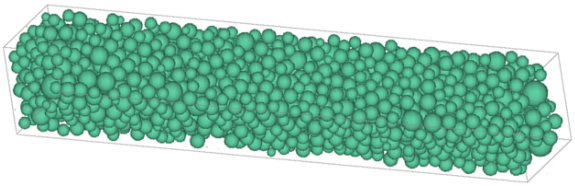

Figure 1: The results of computer modeling of natural powder pouring by the physical-mathematical and computer simulation methods

Recent Publications

1. Izonin, I., Tkachenko, R., Gregus, M., Duriagina, Z., Shakhovska, N. (2022). PNN-SVM Approach of Ti-Based Powder's Properties Evaluation for Biomedical Implants Production. CMC-Computers, Materials & Continua, 71(3), 5933–5947.
2. Izonin I, Tkachenko R, Duriagina Z, Shakhovska N. Smart Web Service of Ti-Based Alloy's Quality Evaluation for Medical Implants Manufacturing. Applied Sciences. 2022; 12(10):5238.
3. Z. Duriahina, A. Pankratov, T. Romanova, I. Litvinchev, J. Bennell, I. Lemishka, S. Maximov. Optimized packing titanium alloy powder particles. – Computation. - 2023, 11(2), – P.1-13.
4. Duriagina Z.A., Pankratov A.V., Romanova T.E. Optimal filling of a given volume with spherical and non-spherical powders for additive manufacturing // Nanotechnology and nanomaterials (NANO-2019): international research and practice conference (Lviv, 27-30 August). – book of abstracts. – 2019. – C. 626.
5. Fischer, A., Litvinchev, I., Romanova, T., Stetsyuk, P., Yaskov, G. Quasi-Packing Different Spheres with Ratio Conditions in a Spherical Container (2023) Mathematics, 11 (9), 2033.
6. Z. Duriagina, I. Lemishka, I. Litvinchev, J. A. Marmolejo, A. Pankratov, T. Romanova,·G. Yaskov. Optimized Filling of a Given Cuboid with Spherical Powders for Additive Manufacturing / Journal of the Operations Research Society of China.

Photograph

Biography

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