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QUICK STUDY ON PRODUCTION MODELS AND THERMOPLASTIC INJECTION MOLDING MOLDS METHOD SELECTIVE LASER SINTERING

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Abstract

This paper addresses some aspects of modern technologies of the future on achieving fast models of several types of materials using different manufacturing methods.

It also presents some details of applications in the SLS injection mold showing some technical details that lead to high economic efficiency.

The paper describes also the metallic materials sintering problem and the molding of different plastic materials categories, as well as the working parameters' of laser.

1. Introduction

Selective sintering processes were developed after 1992 and are based on design and manufacturing experience gained stereo lithography machines, but also on expanding technological research on groups of materials with mechanical and technological properties closer to the functional needs of engineering (ceramics, paper and paperboard, coated, composites).

2.General considerations

The process for rapid prototyping by selective laser sintering is based on the realization of a product by adding successive CAD layers. In this method laser point to point covering the entire cross-sectional area, sintering thin layer of material deposited on the working platform. It requires the construction of a media because the layer of support is above the current layer of material.

The main difference between laser sintering system metals to polymers, is a laser optical system, because the sintering temperature (9000C) requires high laser radiation . For this reason, the laser furnace diameter is reduced to about 350 μm and the laser power to 200 W. The power density must be increased from 25W/mm2 for plastic powder to 700W/mm2 for powdered metal. These machines are generally produced by the American company DTM, which have a high flexibility in terms of material, machinery Sinterstation Sinterstation 2500 or more can run powdered metal parts quartz and polymers based on polyamide.

3.Rapid execution of models (Rapid Prototyping, RP)

The rapid execution model means a set of procedures for the formation of prototypes for direct formation of plastic parts using geometric CAD data. This process is particularly adapted to manufacture automatic models and prototypes used equally as precursors for other transformations.

He succeeded in demonstrating that a certain layer of powder mixtures under the action of the laser beam can reach the local melting temperature of the transition layer from powder to liquid phase. Based on physical properties of powders used immediately after the laser action takes place almost instantaneously, resulting in a local hardening rigid area surrounded by untouched powder laser effect.

Laser sintering operation is shown schematically in figure (Fig. 1)

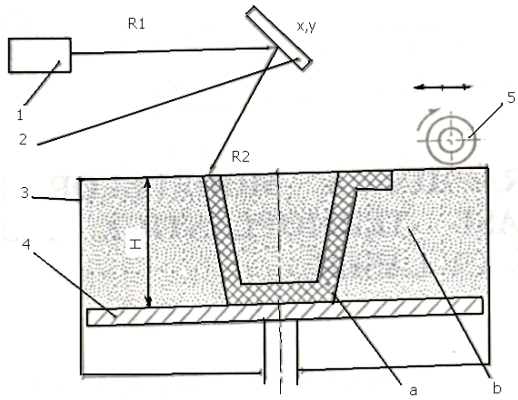

Fig. 1. Laser sintering operation is shown schematically in figure
1 - laser, 2 - scanner, 3 - tank, 4 - mobile platform, 5 - smoothing and drying system, R1, R2-ray laser-part consists of b-powder.

Radiation R1 emitted by a laser scanner 2 reaches a programmed radiation deviates R2 powder mixture to the surface. Due to the complex movement of the scanner in the x, y and z direction mobile table 4 are obtained layers melted and then solidified powder constituent form "a". Composition of the object "a" is achieved through layers, so that after solidification underlay, table four down with two equal $\Delta 2$ displacement solidified layer thickness on a mobile table. by overlaying several layers solidified and adherent to each other to obtain final height Ha object format.

Uniform layer of dust "b" is made with poor image quality cylindrical compaction 5.

The laser beam is produced by a carbon dioxide laser and the scanner is controlled by a computer produces the powder surface points solidified layer linear, surface, is (by moving the laser beam closed contour). Moving the laser beam is made similar stereo lithography. Achieving precision sintered products is influenced by how overlay:

- by the same way when the movements are simple;
- where different directions shifted to 60 ° or 90 °.

4. Materials used in the SLS

Materials used in selective laser sintering process are quite different from metal powder (Mcu3201, Radid Steel 12.0), based on quartz powders or zirconium (S EUSINT quartz, zircon EUSINT HT) and ending with polyamide powders (PA1500, PA2200 etc.).

Metal powders are generally composed of two components: one with a high melting point, called the structural metal, and second low melting point, with glue-like role-based metal powders used in DMLS process has been extended patented around 1980 by Electrolux Rapid Development of Finland, for the production of sintered parts, formed at low pressure. At the current time license for the exclusive use of these patents is owned by German company EOS GmbH.

Using optimal parameters makes the usual volume reduction due to phase sintering metallic powder to liquid form be fully compensated by the increase of volume caused by diffusion of mixture components (powder steel with copper bonding), such that this material undergoes virtually no changes in volume during the laser sintering process.

This method avoids the need for a high temperature in working zone, which would be necessary to lower internal stress produced by the laser sintering of metal powders other.

For selective laser sintering using powder mixtures which melt at low temperatures and low viscosity thermoplastics such as ABS, PA, PC, PVC, etc.. You can also use wax training.

Maximum thickness of powder layers is between 0.1-0.5 mm.
This process can be generated by small pieces or more depending on plant size.

5. Options applied to execution fast injection molds

SLS process of realization of the model can be extended to achieve injection molds using various sintering materials.

5.1. SLS process powder metal-plastic combination.

Instead of thermoplastic powder metal powder can be used in a thermoplastic matrix.

To achieve injection molds for small series using combinations of powder metal materials with plastic. Metal powders are coated with a thin layer of polymer. Selective laser sintering process leads to the formation of mold nests, which will then be placed in steel frames.

You can also execute punches, inserts. By combining them can produce matrix and thus can be achieved by injecting a series of songs so they can be observed all data needed to achieve a large series dies. In such a matrix can inject hundreds of pieces.

Remember this process "Indirect Selective Sintering Process". The procedure is offered in two material combinations:

- Copper - Polyamide low pressure molds used in plastic injection in small series;
- Noble steel - bronze metal casting applications higher injection pressure or high temperature plastics and high pressure.

With this procedure can be done and process complex parts can be used for making molds that can inject thousands of pieces.

Another method is based metal-plastic "Direct Shell Production Casting". This process is built directly form the adhesive injection in a bed of ceramic powder, the sinter.

5.2. SLS process with multicomponent metallic powder

In recent years appeared multi component metal powders. These powders are a mixture of metal powders with high melting points and low. Component with lower melting point component serves as a higher melting point matrix. Grain size and thermal expansion coefficient of both materials are provided so that the final contract between them is minimized.

In the process, "Direct Metal Laser Metering" developed by Electrolux, Rapid Development in Finland is used essentially a bronze-nickel powder mixed with a flow agent and other additives. To achieve the required accuracy, the sintering process must take place with caution, however, resulting in porosity of 30%. Because stiffness is not sufficient for cavity injection is infiltrated with low-melting alloys or epoxy resin. This provides a final porosity of 15%. Inserts or machined cavities can be formed by milling and grinding. Molds are capable of up to 1000 pcs. Can be used to inject parts of PP, PE, PA and ABS.

5.3.Sintering mono-metallic powders.

Procedures to move past trying lately sintering with one component (tool steel).

However, there are special problems:

- High melting point material;
- Pores appear larger in comparison with procedures using plastic;
- A layer of oxides occur locally;
- The piece internal tensions causing deformation.

Take steps to overcome these disadvantages by:

- Optimization of process parameters;
- Improvement of scanners;
- The process under inert gas atmosphere to avoid oxidation.

The process is developed by "Fraunhofer Institut fur Lasertechnic" of Achen. Can be obtained by this method both punches and cavities.

6. Application of SLS

One of the most important applications of selective laser sintering of metal powders for production of metal molds for injection plastics and alloys. The procedure is useful for mold complex shapes in the figure below are some examples of this type of mold. If metal molds with complex configuration is most advantageous use of the process of working on CNC milling machines.

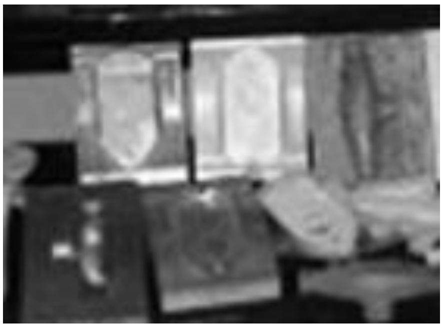

Fig.2. Examples of matrices obtained by the SLS.

Selective laser sintering and infiltrating parts take up to two days depending on their size. The time required computer design (CAD) and their finishing is the same as any other piece worked through - another conventional process. The precision design of planes of separation in injection molds is better is required only manual finishing operations. Durability of metal molds can be improved by plating nickel thickness of 30-40 mm were made. This process increases up to 510 HV hardness, the hardness is comparable to the high hardness steels.

7. Conclusions

The obtained results show that the time of completion of a injected piece isn't proportional to it's size, and that it is influenced by a lot of factors which don't always seem important, like the quality of thenest surface, which cannot be determined using the computer, the thermal conductivity of the active part of the mold and othere elements that cannot be anticipated by the program. All in all, the mold injection computer-based simulation is becoming a necessity for complex pieces as well as in large scale fabrication, judging by the advantages shown here, although the acquisition price is relatively high.

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