METAL POWDER DEPOSITION ON FLAT C45 STEEL SURFACES

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ABSTRACT: A body formed from the metal powders represents an unstable thermodynamic system, a state determined by the fineness of the powders, the roughness of the surface of the grains, their form, the degree of strain- hardness or cold-straining on the deformed areas, the damages of the multicrystalline networks on the surfaces of the grains (vacant locations, dislocations, etc). The basic parameters of the sintering are : the temperature and the sintering duration, the procedure of heating and the environment (the atmosphere) where the sintering is taking place.

KEY WORDS: powders, lasersintering, liquid phase, temperature

1.THE SINTERING OF POWDERS AGGREGATION

The essence of the process of obtaining of the products by metallic powders aggregation is reprezented by the operations of the formation and sintering which determine the appearance of the, increase and stabilization of the contact surfaces, joined by the realization of the cohesion interatomic connexions among the particles.

The formation of the links of consolidation among the powder paticles takes place by running the following phases:

- the formation of the connections type point
- the increase of the connections type point and the formation of the contact surfaces
- the appearance of the new crystalline grains
- the development of the new crystals, their spherization and the dissapearance of the eyepores.

These phases deploy themselves during the formation operations (with or without pressing) and during the sintering operations.The consecutive phases, superposed on a certain part or simultanous are favourized by the plastic flow, superficial diffusion through the whole metal weight, diffusion into the marginal beds of the grains, diffusion within the whole weight of the metal, evaporation and condensation.

A body formed from the metal powders represents an unstable thermodynamic system, a state determined by the fineness of the powders, the roughness of the surface of the grains, their form, the degree of strain- hardness or cold-straining on the deformed areas, the damages of the multicrystalline networks on the surfaces of the grains(vacant locations, .dislocations, etc). The thermic activation of a certain system, by heating for sintering, generates their passing into a state closer to the equilibrium by reducing the free or unoccupied surface [1].

Except these phenomena, same time with the sintering it takes place a process of softening, namely a reduction of the rezistance to deformation of the cristalline grains from the particles, leading to the viscous flow

To the superficial tension of the material of the grains it is opposed a weakened rezistance of the crystalline grains on the contact zones. The value of the superficial tension exceeds the critical tension of flowing – creep tension, at the respective temperature and determines displacings of the gliding plans, therefore a mass transport by the flow in the viscid state of the material [2].

During the sintering, next to the effect of the body contraction, it is produced the continous reduction of the porosity by the decreasing the dimensions and the form of the eyepores. When during the sintering, it is exceeded the melting temperature of a component or of a phase already formed, it takes place the sintering with the appearance of the liquid phase. In this case the mechanism of the mass transport is strongly accelerated by the capacity of moisturing of the liquid phase and by the dilution - precipitation process, being stressed the contraction of the body and the growing up of the new grains.

The basic parameters of the sintering are : the temperature and the sintering duration, the procedure of heating and the environment (the atmosphere) where the sintering is taking place. The duration of sintering has to be co-related to the sintering necessary degree, respectively with the structural parameters imposed and it depends on the sizes of the half-finished product [3].

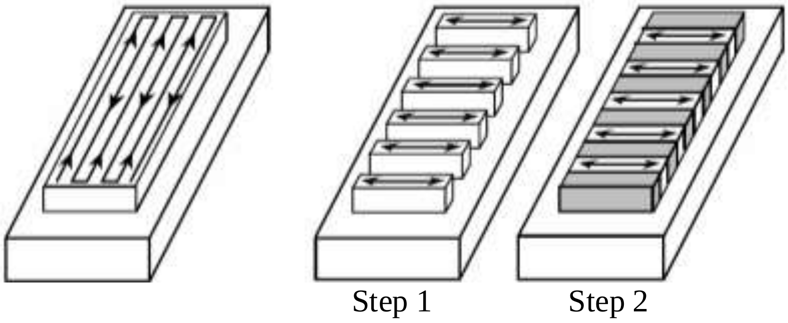


Fig. 1. The chart of the continous and fragmented deposition : a)-continous deposition; b)-fragmented deposition.

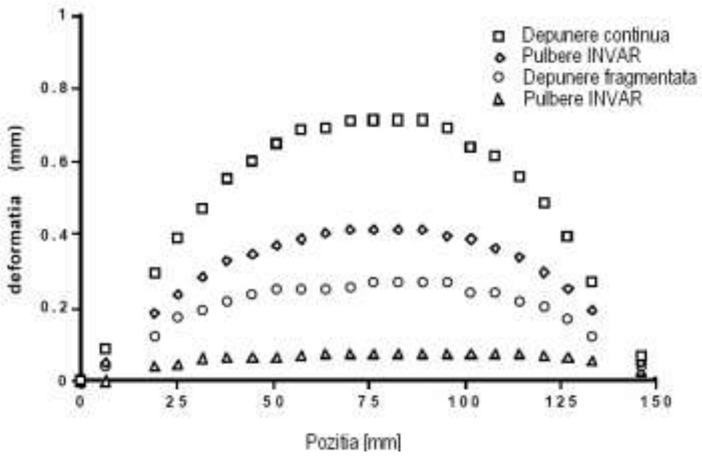


Fig. 2. Comparison between the continous and the fragmented deposition of the powders with or without contents of substances having role of deacreasing of the extension coefficient

For reducing the deforming of the area where is made the deposition due to the thermal extension the deposition route may be splitted. Also, in the composition of the deposed powder may be introduced materials which have as effect the deacrease of the extension coefficient.

The usual routes for the moving of the laser beam for sintering the material on the plane surfaces are shown in the figure 1. In the figure 2 it is represented under the form of a graphic, a comparison between the continous and the fragmented deposition of the powders with or without any contents of substances with the role of descreasing of the extension coefficient.

2. DESCRIPTION OF THE EXPERIMENTAL ACTIVITY

The experiments carried out consisted in the deposition of metallic powders using a laser on flat surfaces made of 4 mm thick C45 steel sheets.

This information about the materials used in the experiments is very important to know prior to the deposition process — firstly, for the proper selection of the metallic powder to be deposited, and secondly, for the comparison of the results [1] [4].

3. STUDY OF THE STRUCTURE AND COMPOSITION OF THE DEPOSITED LAYER

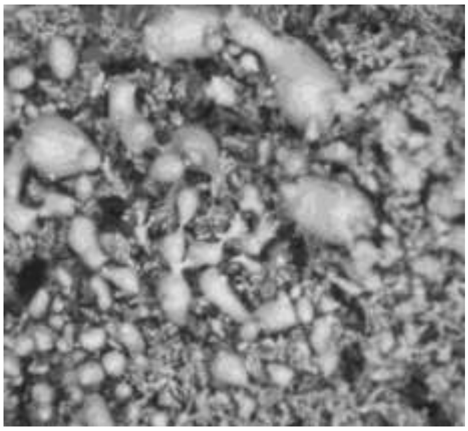
Following the deposition process, the samples were prepared and examined on different surface areas using a JOEL JSM-35 scanning electron microscope (SEM).

Sample preparation for microstructural analysis and microhardness testing was performed according to standard metallographic procedures.

3.1. 316L stainless steel powder deposited on a C45 steel substrate

The deposition was carried out at a temperature of approximately 1400°C, in the presence of a liquid phase. The power of the laser system was adjusted to 0.5 W with a duty cycle of 40%. The molten 316L steel particles adhered to the molten surface layer of the C45 base material (fig. 3). The presence of the liquid phase is evidenced by the formation of dendritic crystals within the deposited structure. The densification of the material is sufficiently high, mainly due to the presence of the liquid phase during the sintering process.

The TiB_2 powder was deposited on the surface of a 4 mm thick C45 steel sheet.



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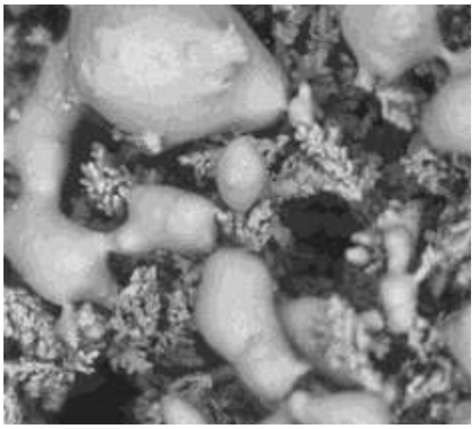


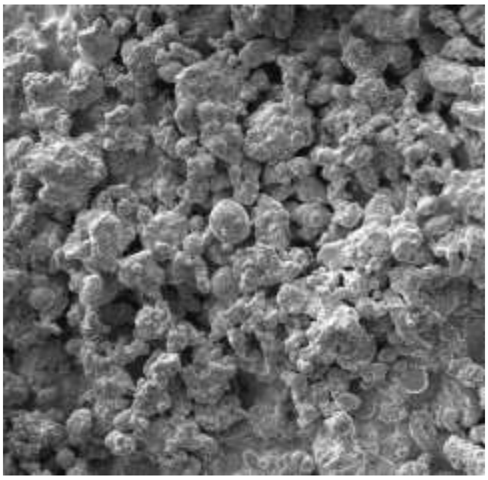
1.2Kx

Fig.3. 316L stainless steel powder deposited on a C45 steel substrate

3.2. TiB_2 powder deposited on a C45 steel substrate

Sintering was carried out at a temperature of approximately 2200°C. The laser system power was set to 1.5 W with a duty cycle of 50%. Sintering occurred in the presence of a solid phase.Since the particles deposited in this experiment had a size of 2–4 µm (very small), the densification was high, with the resulting pores being relatively small and closed. Micrographs (Fig. 4) illustrate this; the TiB_2 particles appear as pellet-like structures, with numerous intergranular necks formed due to material transport during sintering.

The pores are very small relative to the particle size and are also closed.



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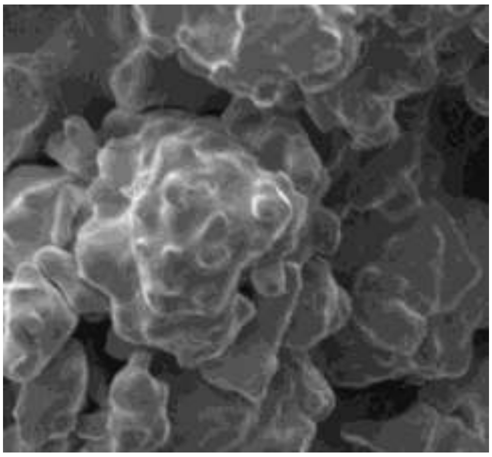

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Fig.4. TiB_2 powder deposited on a C45 steel substrate

4. CONCLUSIONS

-In case of the deposition of the powder of TiB_2 a a support of C45 it was obtained an increase of the microhardness of the material from 60HRC to 190HRC when it was deposed on the disengagement face of the cutter the powder of TiB_2 = 10% in a mixture with steel 316L = 90% respectively 230HRC when it was deposed on the disengagement or emission face face of the cutter TiB_2 = 20% in a mixture with steel 316L = 80%. It was observed that same tme with the increase of the concentration of TiB_2, the hardeness of the deposed material is increasing, too.

-In case of the deposition of the powder of TiB_2 on a support of C45 it was also determined an increase of the material hardness with the increase of the concentration of $TiB_{2,}$ hardness which decreased while the depth of the deposed layer was increasing.

-Measuring the hardness of the cutter on which were made the depositions, it was ascertained a significant increase same time with the increase of TiB_2 till a limit of a deposition unei up to 1,5mm after that starting to decrease.

-In case of the deposition of the powder of 316L on a support of C45 it was determined an increase of the microhardness of the obtained material while the concentration of 316L was increasing. High values of the hardness were obtained at a depth up to 0,5mm , after that starting a sudden decrease.

5. REFERENCES

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