PHYSICAL BASE OF DIRECT LASER DEPOSITION WITH TECHNOLOGICAL APPLICATION

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Direct laser deposition (DLD) [1] is one of new and fast developing technologies of additive production, which allow get a level of process productivity up to several kg/h and produce a metal parts with size up to several meters. Technology base on combination of focused high power laser beam, which heat and melt a substrate and metal powder, with gas-powder jet, which bring metal powder to the active zone. Joint optical objective with nozzle block present a technological head, which move relative the growing part, form it layer by layer.

As a next step in development of laser powder melting, DLD met a number of physical obstacles on the way to fast production of large parts from different metals and alloys. First of all increases of productivity require increases of powder supply and, therefore, increases of laser powder to melt more powder. It lead to elongation of melt bath, that, in its turn, lead to development of Relay-Taylor instability – appearance and grow of waves on the melt pool surface. The linear stability analysis in Lyapunov approach [2] allow to formulate a stability condition, which determines from laser beam and gas-powder jet focusing, and positions of optical and gas jet focal plans relative substrate surface. Usage this condition in design of technological head gave possibility to remove a productivity limitation.

Next problem has been connected with influence of thermal stress, which for large scale products can lead to sufficient changes of product size as well as appearance of product shape instability [3]. Preliminary thermomechanical simulation in this case allow recalculate initial design model of product to technological model, which used for control program for product grow. To provide mechanical stability the procedure of additional ribbing has been invented. Finally the necessity of addition heat treatment, specific for each product shape and material, for elimination of thermal stress, has been established [4].

Large amount of subjects for basic research have been connected with peculiarities of material structure and phase composition in DLD process [5]. Short heating and cooling time in this case lead to inapplicability of thermodynamics for prognosis of material structure and properties, so approach of diffusion – reaction kinetics has been used for this purpose, which, together with large amount of experimental research, gave applicable results.

Finally it is possible to note, that achieved and future progress in the development and implementation of DLD process is strongly provided by wide range of basic physical research, as experimental, as well as theoretical.

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