Physically based bead topology model coupled with electro-mechanical power source model applied for wire and arc additive manufacturing

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Metal additive manufacturing (MAM) has grown, in recent years, very strong interest in academic researches as well as industrial applications. Among MAM processes, wire and arc additive manufacturing (WAAM) became very popular through its advantages in manufacturing of medium and large-scale components [1].

The present work is carried out in the framework of the WAS project [2] which deals with WAAM process. The process relies on an automatized welding process in which a part is built by successively deposed metal bead.

We propose a physically based bead topology model using the equilibrium between the hydrostatic pressure and the capillarity force, under two-dimensional hypothesis. This equilibrium can be described by the Young-Laplace equation. The proposed model can also estimate a bead topology which is deposed on a complex support such as an inclined or a curved one. To do so, the Young equation is used to balance the forces at tri-phase point [3]. Moreover, a deposed melted metal volume is necessary for the bead topology model. By modelling a gas metal arc welding (GMAW) power source system [4], the volume can be estimated and be used as a physical parameter for the bead topology model. Combining the topology and the power source models, the coupling model allows to simulate the topology of a part made of deposed beads via WAAM. In addition to the modelling, experimental profiles of the beads are used to validate the model.

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