Project Title: Process Control of Laser Metal Deposition Processes

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Project Description
Laser Metal Deposition (LMD) is an important class of Solid Freeform Fabrication manufacturing processes. In LMD processes, metal powder (or a wire) is injected into a laser beam where it is heated. The powder is deposited into a melt pool on a substrate (or another layer) where it forms a bead that subsequently solidifies. The LMD process is novel in that it may be used to create functional prototypes and to produce functional gradient material metal parts since different materials can be added from one layer to the next or even from one section to another. Also, sensors with protective shielding can be seamlessly embedded into parts, and parts may be repaired using the LMD process, thus, reducing scrap and extending product service life. Further, very thin parts may be fabricated due to the extremely low processing forces.

The LMD process is very complex and sensitive to conditions such as substrate material and size, part geometry, etc. Therefore, extensive trial and error is typically required to determine a suitable part process plan. Even after conducting extensive experimentation, the
constant process parameters will not always produce a part with the desired geometric and mechanical properties. Work conducted at Missouri S&T has applied systems and control theory to the dynamic modeling and control of LMD processes. One branch of work has concentrated on powder flow control. Instead of utilizing a constant powder flow, which causes overdeposition when the motion system accelerates or decelerates, the powder flow rate is intelligently varied such that a constant powder flow rate per unit length is maintained. In other work, a layer–to–layer control methodology for LMD processes was developed. In this methodology the melt pool temperature is monitored during deposition and the track height is measured between tracks. Using this methodology, the melt pool temperature and the track height have been reliability regulated during deposition.

Publications


