Diagnostics and sensing for laser based additive manufacturing: Lessons learnt from laser micromachining and welding

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Additive manufacturing (AM) processes have entered the industrial manufacturing reality over the last decade. As the initial hype is overcome and more realistic expectations are formed around this theme the industrial demand moves towards higher process performance. The process essentially relies on the use of a high brilliance laser beam with moderate power output to fuse metallic powders to generate 3D structures in a layer-by-layer fashion. Laser powder bed fusion (PBF) is arguably the most widely used and studied AM process both in academia and in the industry. Laser directed energy deposition (DED) with powder or wire feedstocks are also gathering increased attention for larger components. In terms of process physics, laser based additive manufacturing processes could be seen as an extended laser microwelding operation with powder and wire feedstock. From this point of view, several lessons can be learnt from extended research outcomes on laser micromachining and welding processes that have been developed over the years.

This work investigates the diagnosis and sensing needs of laser based PBF and DED processes for improving process and machine capabilities. Tools for process comprehension based on high speed imaging, thermal emission monitoring and spectroscopy are discussed. Process cues in terms of required spatial, temporal and wavelength resolution are shown. Practical examples on different processes are discussed.