Additive Manufacturing with Wire – Comparison of Processes

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Abstract. Additive manufacturing (AM) processes involving the use of an electric arc, laser or electron beams and a deposited material in the form of a wire are efficient methods enable making of elements of complicated shapes and which are made of expensive technical alloys, e.g. stainless steels, nickel or titanium alloys. The demand for fast prototyping results from the development of new technologies in the automotive, aviation and machine-building industries. Generally speaking, AM offers numerous advantages. At the core of these are reduced production and material costs, reduced development and lead times, and improved performance. However, not all of the current AM processes are equally suited to provide all of these advantages. Compared to the powder (Table 1) and wire systems some aspects can be underlined. During the powder deposition process a certain amount of powders cannot be caught by the melt pool. The powders are blown to the surrounding environment, which causes potential hazard to the operators and environment. Compare to powder feeding, wire feeding method has higher material usage efficiency. Almost all the materials fed into the melt pool during the process are used to form the deposit. In the paper the advantages of AM methods are presented. The main focus of the work was to present the results of AM process with wire of stainless steel. The evaluation of the microstructure and the mechanical properties of AM parts, manufactured by arc, laser beam and electron beam processes, are presented. The analysis revealed that the properties of the deposited parts are not worse than that properties guaranteed by producer of filler material (Table 2). Thus the fast AM technologies involving the use of a wire and an arc or a laser and an electron beams as the source of energy should gain recognition among entrepreneurs intended to implement innovative solutions in their companies.

TABLE 1. Comparison the powder bed and wire fed techniques for AM technologies

Feature	Powder bed AM	Wire fed AM
Size	Small to medium scale parts and prototypes	Medium to mega scale parts and structures
Speed	Material deposition averages between 0.1 kg and 0.2 kg per hour	Materials deposition ranges between 2.9 kg to 9 kg per hour
Complexity	Powder bed AM inherently offers more precise, granular control over part geometry and details	Systems produce near-net shape parts required some finishing. Dual wire feed method enable the invention of next generation metal alloys
Companies	3D Systems, Arcan, EOS, Renishew, SLM Solution etc.	Sciaki, Norsk, Trumpf, CVE, PTR, ProBeam

TABLE 2. Comparison of the mechanical properties of AM deposited material

	$R_{0,2}$ [MPa]	**R_m [MPa]**	**A_5 [%]**
Laser beam	-	710	16
Electron beam	581	723	38
MIG	427	651	40
Filler material (LNM 307 Lincoln Electric)	400	630	40