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Abstract

Linking Additive Manufacturing and Sensor Integration: A Direct Path towards Structural Electronics? †

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Additive manufacturing (AM) of polymers, metals and ceramics has received tremendous attention since maturing from a prototyping to a full-fledged manufacturing technology for geometrically complex objects. Several products have already been realized on a commercial basis, covering application areas as demanding as the aerospace industry. Additive manufacturing offers a design freedom which is unparalleled by subtractive manufacturing or forming processes. This feature would, in itself, create business opportunities in several scenarios that build on high complexity or customization, allowing, for example, assemblies of numerous parts to be integrated in a single component, as well as structurally optimized bionic designs. All this is true for AM parts made from a single, homogeneous material. This, however, is not the end of the approaches' generic capabilities. Instead, more and more technologies are emerging which use the fact that most AM approaches grant direct access to each individual voxel of a component volume to locally modify material properties. Some processes even allow the selective deposition of different materials. Besides hybrid approaches, it is these specific solutions which allow the creation of a direct link between Additive Manufacturing and Sensor integration, ultimately leading to the vision of structural electronics or 3D-printed electronics in a single manufacturing system, or even a single process.

The presentation explains the different classes of Additive Manufacturing processes available and attempts to classify them with respect to their capability of realizing (a) multi-material parts and (b) parts with integrated interconnects, sensors and/or electronics. Practical approaches to the creation of structural electronics parts via AM techniques are discussed. Typically, these rely on a more or less tight integration of different manufacturing processes—typically a generic AM process which is combined with one or more direct write or similar processes in a manufacturing chain, a manufacturing cell or even a single manufacturing system. Beyond these, special attention is reserved for AM techniques that allow in-process switching of materials at high resolution: in principle, these have the potential to realize complex systems, not by a combination of processes, but via a single deposition and consolidation process. Further to the introduction of processes, application scenarios which benefit specifically from the combination of AM and sensor integration are presented. The presentation builds on the authors' previous studies in the field [1–3].

Conflicts of Interest: The authors declare no conflict of interests.

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