Material and process development for additive manufacturing of metals

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Additive Manufacturing represents a group of manufacturing processes in which material is usually added layer-by-layer –in contrast to subtractive, i.e. material-removing manufacturing processes such as machining– in order to create complex components and assemblies.

The most common processes are powder-bed based, i.e. a powder layer is applied within a processing chamber in a vacuum atmosphere or shielded by an inert gas. This powder layer can be preheated prior to a focused beam source selectively melting the two-dimensional cross-section of a three-dimensional part. This process is repeated with multiple layers of several tens of microns in thickness each until the near-net-shape part is completed.

These technologies promise fast product development and tool-free manufacturing, customizable geometries with internal structures and cavities as well as novel materials and material properties.

The focused beam source can be either an electron beam or a laser beam. In both cases the interaction between powder bed and beam source is a highly complex process, with various physical phenomena playing an important role.

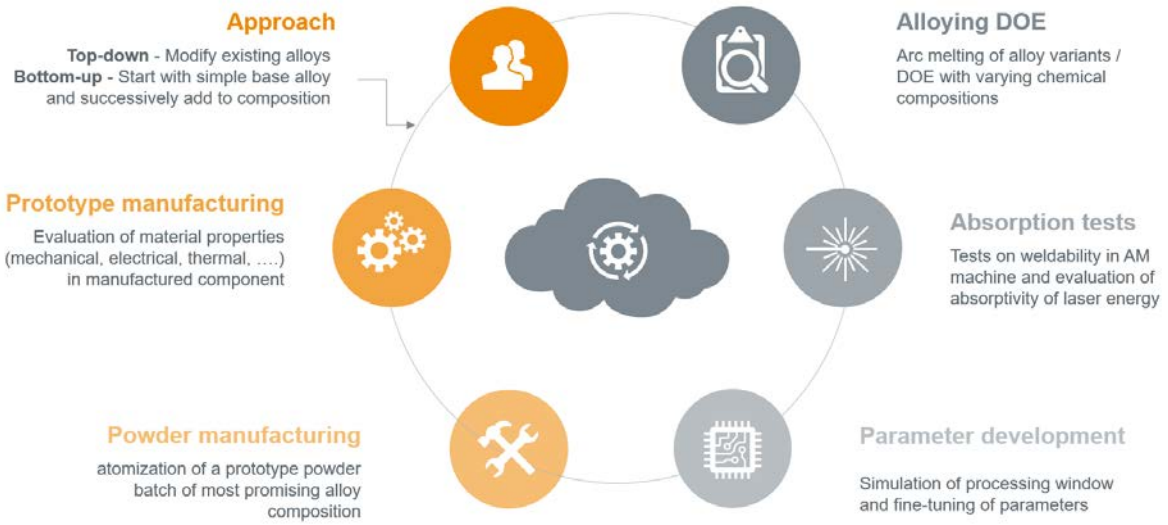

Figure 1: Material development cycle for powder-bed based additive manufacturing processes

The resulting properties of built parts are a complex function of the properties of the used material, powder, machine and processing parameters.

The interplay between all these individual aspects has yet to be fully understood.

The AM group of Heraeus has developed a simulation aided approach to accelerate material development, make it more robust and better transferrable between various AM machines of different specifications. By correlating simplified melt pool simulation models with small-scale experiments, a rapid approximation of the processing windows for dense parts with a given material and machine can be conducted (Figure 1). The results show, that this approach can successfully predict processing parameters and thus accelerate and enhance material development.

Due to the unique processing conditions with exceptionally high heating and cooling rates and the material being created within the process, materials which cannot be cast or machined with traditional manufacturing methods can be processed by Additive Manufacturing.

Examples from various material classes will give an overview of the latest developments in materials for Additive Manufacturing.