Feedstock Quality Assurance

Supervision of the mixing process of feedstock for quality assurance and defect reduction

Use case 7 – Fraunhofer IFAM

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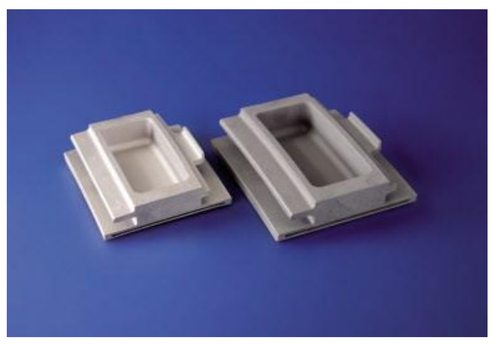
Mixing different components is an important step of process engineering across various industries, ensuring homogeneity, consistency, and optimal performance of the final products. This process step is crucial for processes such as metal injection molding (MIM), a manufacturing process that combines the advantages of plastic injection molding and powder metallurgy to produce complex metal parts.

The role of mixing of Feedstock for Metal Injection Molding

1. Homogeneous powder-binder dispersion: achieving a uniform distribution of metal powders and binders is crucial to obtain consistent feedstock quality. Proper mixing ensures that the binder coats each particle, enhancing the green part's strength and minimizing defects.
2. Consistency in particle size and composition: Precise control over the particle size and composition of the feedstock is vital to achieve dimensional accuracy and mechanical properties in the final sintered parts. Mixing facilitates the blending of different metal powders and additives, ensuring a consistent composition throughout the feedstock.
3. Avoidance of segregation and defects: Inadequate mixing can lead to particle segregation, non-uniform binder distribution, and the formation of defects like voids or inclusions. Effective mixing techniques, such as powder-binder mixing equipment or twin-screw extruders, help mitigate these issues, resulting in high-quality feedstock and sintered parts.

Initial metal powder

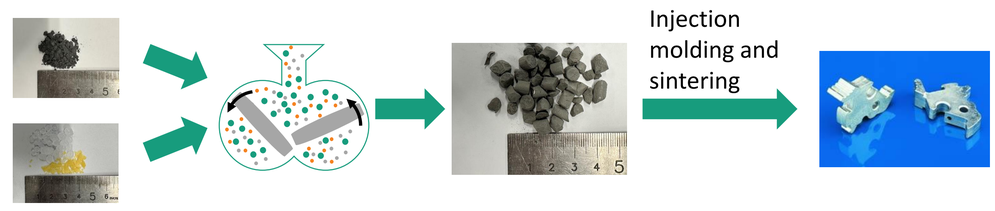


Green part and sintered metallic part

Benefit of Ontologies for Quality Assurance in Mixing of Feedstock Process

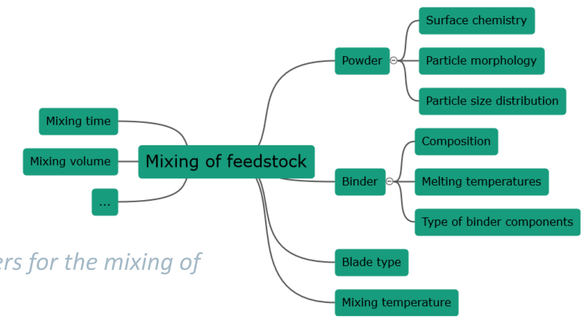
1. Optimization and Control: Ontologies can capture domain-specific knowledge about the mixing process, including parameters, materials, and equipment. By integrating real-time data and process models, ontologies can assist in optimizing mixing conditions, ensuring consistent feedstock quality, and enabling real-time process control.
2. Defect Detection and Prevention: Ontologies can encompass knowledge about the critical factors influencing feedstock quality and the occurrence of defects. By applying reasoning and inference techniques to ontological data, potential defects can be identified early in the mixing process.
3. Rheological Control: The rheological properties of the feedstock play a crucial role in the success of the metal injection molding process. Mixing with precision and control helps achieve the desired rheological characteristics, such as viscosity and flow behavior, which directly impact the moldability and fillability of the feedstock. Ontologies can assist in capturing and analyzing data related to rheological properties, enabling better understanding and control of the mixing process to ensure optimal feedstock flow and mold filling, resulting in high-quality sintered parts.

I.



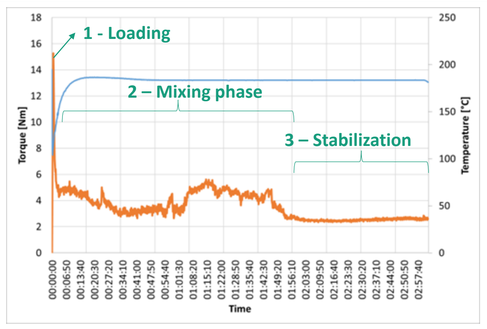
Process steps from initial material to a finale sintered part

II.



Input parameters for the mixing of feedstock

III.



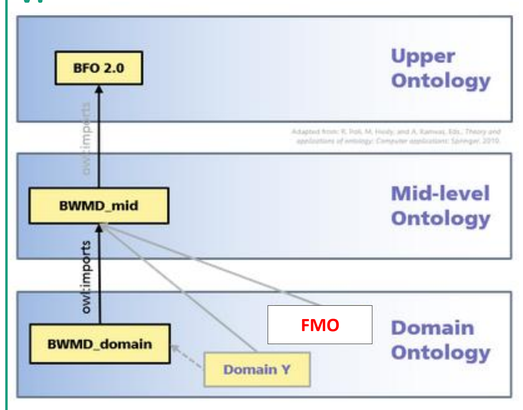
Mixing phases visible in the torque-time profile

The characteristics of the individual phases are influenced by the above-mentioned input parameters. Changes in the feedstock quality can result in adjusted injection molding parameters or quality fluctuations of the final components.

IV.

- Setup of an DLO “Feedmix” (FMO) and integration into BWMD-MLO
  - Material and process based
  - Modular setup TLO+MLO(+DLO)
  - Developed with OntoCommons partner Fraunhofer IWM and EMI
- Following a how-to from BWMD-developers
  - Integration of categories and properties in Protégé
  - Integration of those categories and properties into Knowledge-BaseBuilder
  - Export of knowledge graph into Excel table for input of process parameters

V.



Integration of the domain ontology FMO into the mid-level ontology BWMD

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