

## Binder jet 3D printing – process parameters, structure, properties and challenges

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### ABSTRACT

Binder jet 3D printing (BJ3DP), a non-beam-based additive manufacturing (AM) method, is the technology in which powdered material is deposited layer-by-layer and selectively joined in each layer with binder and then densified through sintering or infiltration. Binder jetting of metals holds distinctive promise among AM technologies due to its fast, low-cost manufacturing; stress-free structures with complex internal and external geometries; and the isotropic properties of the final parts. Also, by taking advantage of traditional powder metallurgy, BJ3DP machines can produce prototypes of metal parts in which material properties and surface finish are similar to those achieved with metal injection molding or traditional powder metallurgy. Therefore, a comprehensive overview of the physical processes during printing and the fundamental science of metallurgical structure after sintering and post-heat-treatment steps are provided in this work to understand the microstructural evolution and mechanical properties of BJ3DP parts. Further, to determine the effects of the BJ3DP process on metallurgical properties, an empirical framework to describe the role of powder morphology and size distribution, printing process and parameters, sintering and post-heat-treatment is discussed. With the growth of AM and the need for post-processing in BJ3DP parts, an understanding of the evolution of densification within large parts during sintering is necessary. An example of binder jetting process is presented on alloy 625 and microstructural evolution and mechanical properties of the produced parts are characterized.

### BIOGRAPHY

Amir Mostafaei is a Manufacturing Futures Initiative (MFI) Postdoctoral Fellow in the Materials Science and Engineering Department at Carnegie Mellon University. His PhD research was in additive manufacturing, namely binder jet 3D printing of metal powders including alloy structural, biocompatible and magnetic shape memory alloys. His current research is focused on powder bed fusion additive manufacturing of Ni-based and Ti-based alloys. His work aims to develop processing windows to manufacture parts with controlled columnar and epitaxial structure.

