Summary

This doctoral dissertation focuses on the development of 3D printing technology using the Binder Jetting method to fabricate functional ceramic casting filters designed for the precision casting of nickel-based superalloys. The study presents an overview of the properties of nickel superalloys and the technologies employed in their precision casting. Key challenges, such as casting defects, and the role of ceramic filters in molten metal filtration—critical for ensuring high-quality castings—are thoroughly discussed. A review of additive manufacturing techniques for ceramic materials is provided, with particular emphasis on Binder Jetting as an innovative approach to designing and manufacturing filtration structures. The experimental section includes analyses of powder morphology, particle size distribution, sintering processes (conventional and microwave), and the mechanical and filtration properties of the manufactured components. 3D printing parameters, such as layer height, binder saturation, and filtration structure geometry, were optimized. The research findings demonstrate that Binder Jetting technology allows for precise control over filter parameters, such as apparent density, surface roughness, and compressive strength, significantly enhancing their efficiency in casting processes. Casting trials confirmed the effectiveness of the developed filters in reducing casting defects and their applicability in industrial use. The developed 3D printing technology for ceramic filters enables the precise tailoring of their properties to meet the specific requirements of precision casting processes. The conclusions drawn from the research highlight the high efficiency of filters produced by the Binder Jetting method and their potential to use for industrial applications, representing a significant contribution to the advancement of modern precision casting technologies.