Microstructure and Mechanical Properties of Co-28Cr-6Mo for Medical Applications: Casting vs. Additive Manufacturing

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Cobalt-based alloys were initially developed for their excellent mechanical properties, making them suitable for applications in the aerospace industry. Later, their outstanding corrosion resistance and biocompatibility led to their widespread use in the medical field. Among these materials, Co-28Cr-6Mo has become the most widely used cobalt alloy for orthopedic implants such as knee joint replacements, due to its combination of strength and biocompatibility.

Traditionally, components made from Co-28Cr-6Mo have been manufactured using precision casting techniques. In recent years, additive manufacturing technologies have emerged as a promising alternative, enabling the production of patient-specific implants with intricate geometries and offering the potential for creating porous structures. Among these technologies, Selective Laser Melting (SLM) is the most commonly used.

This study presents a comparative analysis of Co-28Cr-6Mo alloy produced by precision casting and by SLM, focusing on differences in microstructure and mechanical properties. The SLM-produced samples demonstrated a significantly finer microstructure and, as a result, exhibited enhanced mechanical properties. Tensile testing revealed an increase of approximately 50 % in the yield strength of the SLM material compared to the cast alloy. A smaller difference was observed in hardness, with the cast sample reaching 330 HV 1 and the SLM sample 380 HV 1.

To comprehensively evaluate both fabrication methods, mechanical testing was supplemented with detailed analyses of the microstructure and phase composition. The results suggest that SLM is a viable and potentially superior alternative to casting for the fabrication of orthopedic implants, provided that the processing parameters are carefully controlled and optimized.

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