Hybrid Manufacturing and Performance Evaluation of β Ti-Alloy Stents

Peter Ibrahim[1, 2], Moataz M. Attallah[2]

1- Mechanical engineering department, Faculty of Engineering, Cairo University, Giza, Egypt
2- School of Metallurgy and Materials, University of Birmingham, Edgbaston, B15 2TT, UK

Corresponding author: m.m.attallah@bham.ac.uk

In a competitive and critical process such as manufacturing of arterial stents, every small improvement counts towards improved and risk-free lives for enormous number of cardiovascular diseases' (CVDs) patients. In this study, the authors replaced the commercial alloys used for stent manufacturing such as Ti64 and SS316L and NiTi with novel β-Titanium (TNTZO) alloy [1] to reduce the elastic modulus gap with body tissues and avoid toxic effects of Aluminium and Nickel. Also, using hybrid manufacturing (additive + subtractive) allowed customisation of thin-walled tubes to match the vessel exact geometry, plus benefiting from the high precision of laser micro-machining to cut complex strut designs without the need for supporting structures [2, 3]. LPBF parameters ware optimised for maximum tube integrity and minimum dimensional errors. Open design stent with 3.5 mm hanging thin struts was cut out of the built tubes successfully. The stent surface roughness was improved using electropolishing for better cell attachment. The stent passed standard ASTM F2606-8 mechanical testing with no strut failures. During deployment FE simulations, the crimping stage showed up to 74% stent diameter reduction ratio by reducing strut width from 200 µm to only 80 µm. The thinner the struts, the lower the crimping forces required (< 1 N). It also showed higher spring back effect after inflating stage which is suggested to reduce the stresses and restenosis in the blood vessel after stent deployment [4]. The hybrid manufacturing route when combined with superior novel alloys could bypass many manufacturing and material limitations to make custom patient-specific stents.

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