



Comparative study on Mechanical properties of 316L stainless steel and Nickel 400 alloys

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ABSTRACT

316L stainless steel, Nickel, tantalum and platinum alloy are some materials used in the stent manufacturing. Since stent serves one of the most important functions, we have to select the best material for the manufacture of stents.

Stent materials are selected based on the important mechanical properties required during stenting. The most important property being biocompatibility.

Biocompatibility is the ability of a material to be in suitability with the body tissues without causing any toxic side effects. In this work, a comparative study to conduct the suitable material for stent is performed on two alloys called 316L stainless steel and Nickel. The tensile test and three point bending test of the stent materials were analysed with UTM machine and tensile testing machine.

This work is mainly focusing on mechanical properties of two materials: 316L Stainless Steel, Nickel.

INTRODUCTION

- In our Human body the most important organ is Human heart. The coronary arteries are help to carrying oxygen rich blood through our Heart.
- But many times plaques start forming in the arteries, clogging them as a result. This results in a condition known as Coronary Heart Disease (CHD) or Coronary Artery Disease (CAD). This can lead to heart attacks due to damage in heart muscles.
- They are generally made out of metal mesh. In early period, stainless steel was most commonly used material for production of stent material.
- To checking the stent material its required to check the mechanical properties..

LITERATURE SURVEY

- The work on stents have been done by many renowned scientists and researchers. The stent model was chosen and the various properties required for the stent materials as data were collected and noted. The materials used for testing were selected.
- The Physical properties of the stent material is the preliminary task of this project. Allison C. Morton, David Crossman, Julian Gunn had explained in his paper "The influence of physical stent parameters upon restenosis" about the various physical properties and parameters required for testing an stent material.
- The selection of stent materials is done by evaluating its properties. Out of this, the most important property that a stent must have is biocompatibility. If the material isn't biocompatible in our body, the reaction between the stent and the chemicals in our body can cause problems in the later stages. Two materials were selected for this project. S. Zhu *et al* , M. Colic *et al* , Martha Es-Souniet *al*, R. Guidoinet *al* provides valuable data regarding the biocompatibility of 316L stainless steel, Nickel.

- High nitrogen nickel-free austenitic stainless steel of a promising coronary stent material. The types of methods, their features were deeply studied by YANG Ke, REN YiBin & WAN Peng in their respective papers which were noted down.
- The stent fracture associated with drug-eluting stents is the most integral part of this study. The various fracture and methods to perform the stent test were noted. Michael S. Lee, MD, Daniel Jurewitz, BA, Joseph Aragon, MD, James Forrester, MD, Raj R. Makkar, MD, and Saibal Kar, MD have described about the various fractures that occur in stents which have been studied.

Testing methodology

Tensile testing

- Tensile testing is one of the main procedures for testing the maximum elongation and tensile strength of the stent material.
- When we applied the tensile load of 21650 N of 316L stainless steel alloy and we got the ultimate tensile strength of 515.48 N/mm² in the graph plotted by the help of Universal Testing Machine (UTM)
- The Nickel 400 alloy is also tested at the maximum tensile load of 16470 N and we got the ultimate tensile strength of 391.14 N/mm² in the result by the help of Universal Testing Machine (UTM)
- These tensile testing shows that 316L stainless steel has more tensile strength than Nickel 400 alloy. Its because of low content in stainless steel and 316L stainless steel alloy has better Elastic property than Nickel 400 alloy. So stent main property is elongation and study shows that 316L stainless steel has better choice for 316L stainless steel than Nickel 400 alloy.

Three point Bend Testing

- Expansion of stent is focused when during the testing and three point bending test is required for analysing the expansion and we carried out the Three point bending test by 600 Series High Force Hydraulic Bend Test Machine.
- We tested the 316L stainless steel and Nickel 400 alloy metals and we get the result of the two alloys and compared by the help of graph plotted in computer.
- Nickel 400 alloy have a thickness of 30.56mm has been conducted three point bending test and found that when we applied maximum force of 9.180kN then it bended in 35.00 mm displacement.
- 316L stainless steel have a thickness of 31.42mm has been conducted three point bending test and found that when we applied maximum force of 10.950kN then it bended in 36 mm displacement.
- We analyse the two result and find that 316L stainless steel has more ductile than Nickel 400 alloy. So 316L material can be more plastically deformed without fracture at maximum force of 10.950kN and its better choice for manufacturing stent material than Nickel 400 alloy.

CONCLUSION

- Done the comparative study by the help of mechanical equipments. Two types of stent materials were analysed in this project namely: 316L stainless steel, Nickel 400 alloys.
- By the result of two alloys tested, it was seen that 316L stainless steel has the more ductile and ultimate tensile strength than Nickel 400 alloy. The 316L stainless steel has more suitable for choosing as stent material according to the test we carried out.

REFERENCE

- C. Bonsignore, "Open Stent Design," has published in ResearchGate publication, January 2012, DOI: 10.6084/M9.FIGSHARE.95614
- YANG Ke, REN YiBin & WAN Peng, High nitrogen nickel-free austenitic stainless steel: A promising coronary stent material, Published on SCIENCE CHINA Technological Sciences (2007)