Chapter 3
Fabrication of Porous NiTi Alloy Using Organic Binders

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ABSTRACT
Nitinol has growing applications in aerospace industries, MEMS, and bio-medical industries due to its unique properties of pseudo-elasticity, bio-compatibility, and shape-memory effect. Behaviour of NiTi alloy can be changed by altering the composition, modifying the porosity, and applying external thermal and mechanical treatment. In this chapter, porous NiTi alloy with powder metallurgy is fabricated by varying the composition of polypropylene as an organic binder from 0% to 15%, and Young’s modulus and porosity of porous alloy has been evaluated. The effect of process parameters—compaction pressure, sintering temperature, and sintering time—are evaluated using Taguchi L16 orthogonal array. These particles initially act as a binder but with the increase of temperature, the organic particles evaporate and create pores. With the increase of organic particle percentage, the porosity increases while Young’s modulus decreases. SEM was used to characterize the fabricated porous NiTi alloy.

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INTRODUCTION AND LITERATURE REVIEW

Equi-atomic Nitinol (Ni_{50}-Ti_{50}) is categorized as a smart material due to its distinctive characteristics viz., shape memory effect and super elasticity, etc. Therefore, this alloy has many applications in engineering fields’ (viz. micro-electromechanical-systems (MEMS) in aerospace, aircrafts, electrical switches, actuators and vibration absorbers, etc). Nitinol is also used in orthopaedic implants, cardio stents, orthodontic devices, etc. because of its good biocompatibility, self expanding behavior and high strain recovery (Castleman et al., 1976; Sharma et al., 2015a; 2015b).

Shape memory effect (SME) is the property by virtue of which a material can regain its original shape from permanent position after some thermal changes. The alloy representing this characteristic is known as shape memory alloys (SMA). Ni-Ti exhibit equi-atomic intermetallic compound of nickel and titanium, which can undergo a reversible solid state phase transformation from ordered cubic crystal structure (B2) called austenite to distorted monoclinic (B19’) called martensite. Shape memory behaviour is of two types

1. One way (1WE)
2. Two Way (2WE)

When only the parent phase regain its original position it is 1WE while in 2WE, SMA remember the shape of both parent and product phase and it can be accomplished by heating and cooling the specimen. So, 1WE SMA remembers only one position, which it can attain after some appropriate thermal changes. In 2WE SMA, material remembers two positions, one for low temperature and another for high temperature. Figure 1 represents the transformation temperature range for NiTi alloy, which varies from 143K-351K.

Biocompatibility is a property by which a material can be used in a bio-fluid environment for a long time without any reaction with the bio-media (Catauro et al., 2004). In case of equi-atomic NiTi, a protective layer of TiO₂ is formed that prevents the release of Ni⁺ ions and improves the corrosion, and hence shows good biocompatibility as verified by Es-Souni et al. (2005) through in-vitro cytotoxicity test. NiTi is mostly utilized in surgical devices and coronary stents due to its self-expanding nature and anti-thrombosis property. Thrombosis is a property of material in contact with bio-fluid to clot the white/red thrombus on its surface. NiTi stents exhibit negligible thrombosis as compared to stent made of stainless steel, wherein the later material, the probability of corrosion due to hostile electrolytic environment of the human body is high (Whitcher, 1997; Thierry et al., 2002; Furie and Furie, 2008).
Effect of Process Parameters on MRR and Surface Roughness in ECM of EN 31 Tool Steel Using WPCA


Simulation and Validation of Forming, Milling, Welding and Heat Treatment of an Alloy 718 Component
