1. Introduction

Since the discovery of their unique properties, SMAs have been the focus of significant interest for a wide variety of applications. With the discovery of nitinol (NiTi), a mechanically impressive titanium alloy that exhibits a large shape memory effect (SME), these applications have sky-rocketed. Ranging from the prosaic, for use in mobile phone antennae and eyeglass frames, to cutting-edge applications in mobile phone antennae and eyeglass frames, to cutting-edge applications such as stents (as shown in Fig. 1), orthopaedic staples and even occluding structures to heal congenital heart defects [1,2]. While alternatives to many of these items existed in some form prior to the use of SMAs, the thermo-elastic transition of the SME has allowed for significant improvements.

Unfortunately, concerns have been raised about the composition of nitinol, specifically with the presence of nickel, a known allergenic carcinogen that exhibits one of the highest sensitivities in metallic allergen tests [3]. While techniques such as surface modification have been researched in an attempt to mitigate this, there is nevertheless an incentive to produce a completely biocompatible implant material still capable of exhibiting the desired SME. A number of authors have attempted the production of natively biocompatible SMAs; for example, extensive work on Ti–Nb and the related Ti–Nb–X system (where X = Zr, Ta, Au, O) has yielded alloys with superelastic strains as high as 4.2%, sufficient for most biomedical applications [4–6] without sacrificing biocompatibility. However, while these are extremely promising, there is another concern beyond the biochemical effects of the alloy: the Young’s modulus of equiatomic NiTi is significantly higher than human bone [7,8]. Though a high Young’s modulus is acceptable for a number of implantation roles, the high stiffness can lead to problems when utilized in orthopaedic implants [9]. Herein lies a problem; although higher than that of bone, the elastic modulus of NiTi is still lower than that of many other alloys. As obtaining still lower moduli requires a dedicated effort during the design process, it is clear that the reduction of modulus must be considered concurrently with the thermoelastic behavior of the alloy. To that end, this article will review the literature concerning the field of biomedical SMAs and seek to outline and address the primary concerns associated with designing an SMA without sacrificing bio- or osteocompatibility.

**Keywords:**
- Mechanical properties
- Titanium
- Shape memory
- Biocompatibility
- Superelasticity

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