Chapter 6
Processing and Applications of Shape Memory Alloys

Sudipto Datta
https://orcid.org/0000-0003-2161-6878
Indian Institute of Science, Bangalore, India

Nipun Jain
https://orcid.org/0009-0008-8270-9449
Indian Institute of Science, Bengaluru, India

Yusif Olatunji Waidi
https://orcid.org/0000-0002-5728-1769
Indian Institute of Science, Bangalore, India

Ranjit Barua
https://orcid.org/0000-0003-2236-3876
Indian Institute of Engineering Science and Technology, India

ABSTRACT

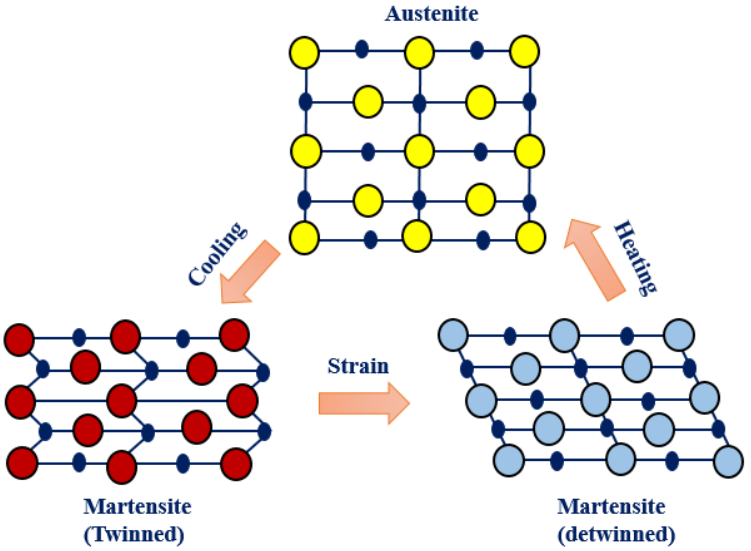
SMA (shape memory alloys) materials are a kind of smart material that undergoes shape changes with respect to temperature variations. In this chapter, the authors focus on the microstructure, classifications, fabrication, and future applications of these materials in brief. They discuss the four main types of SMA processing techniques, which include mechanical, thermomechanical, powder metallurgy, and melting route. Finally, its applications in various fields like transportation, civil structures, robotics, aerospace, automation, and medical fields will be briefly discussed.

DOI: 10.4018/978-1-6684-9385-4.ch006

1. INTRODUCTION

Shape Memory Alloys (SMAs) are a special material that can regain shape when the temperature rises (Hu et al., 2005). SMAs are also widely referred to as memory alloy, memory metal, muscle wire, and smart metal. These one-of-a-kind materials continued to enhance the achievement in accordance with the demand for the engineering sector in general; form Because of qualities such as increased strength, higher strain recovery, lightweight, high stability, and so on, memory alloys are used in heavy engineering (Zhao et al., 2019). Ni-Ti is the most often used SMAs (Liu et al., 2014). Ag-Cd, In-Th, and Cu-based alloys are some further examples. The sophisticated material called form memory alloy exhibits a shape-memory effect and exceptional elasticity. These qualities distinguish them from other materials (Li et al., 2016). The shape memory effect is concerned with recovering a distorted material to its previous shape during heating; in other words, the material's capacity to restore its shape under thermal load. This feature allows them to restore their original shape after being distorted by heating to a crucial temperature (Velvaluri et al., 2021). During a mechanical loading and unloading cycle, super elasticity deals with non-linear recoverable stresses (Kim et al., 2021). Figure 1 shows the shape memory effect's microscopic phenomenology, and Figure 2 shows the pseudo elastic effect connected with microscopic phenomena.

Figure 1. Phenomenology of the microscopic shape memory effect



Nano-Scratch Response of Diamond-Like Carbon Film Deposited by Pulsed Direct Current Magnetron Sputtering

T. Koch, M. Lackner, A. Pauschitzand Manish Roy (2020). *International Journal of Surface Engineering and Interdisciplinary Materials Science (pp. 19-37).* www.irma-international.org/article/nano-scratch-response-of-diamond-like-carbon-film-deposited-by-pulsed-direct-current-magnetron-sputtering/257250

Cutting Edge Hybrid Materials for Enhanced Electrocatalysis in Alkaline Hydrogen Evolution

Anil Kumar, Pooja Nehra, Durvesh Gautam, Yogendra Kumar Gautam, Naveen Vashishthand Satyendra Singh (2025). *Novel Energy Storage and Conversion Technologies for Two-Dimensional MXenes and MBenes (pp. 121-154).*
www.irma-international.org/chapter/cutting-edge-hybrid-materials-for-enhanced-electrocatalysis-in-alkaline-hydrogen-evolution/374629