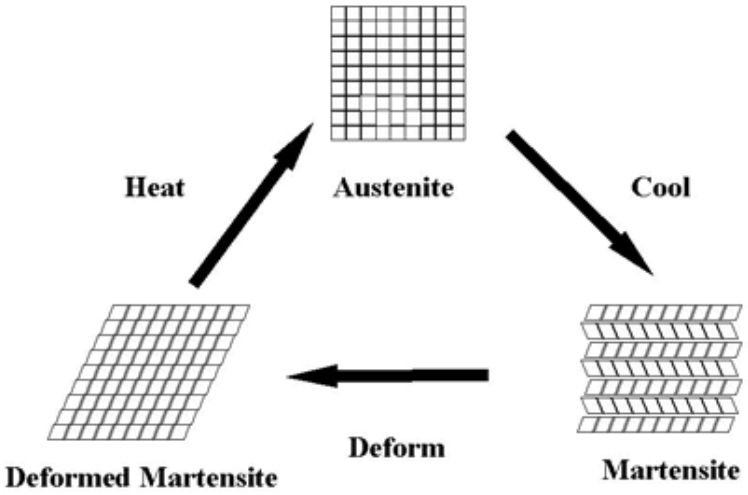
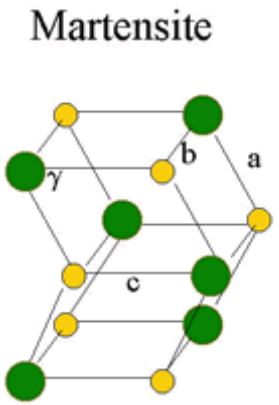
Memory Metals

Nitinol, which is a nickel-titanium allow, is often referred to as a “memory metal” or a “smart material” due to its ability to “remember” arrangements of atoms at different temperatures, and to retain the bulk shape of a material (other examples include Au-Cd, Cu-Al-Ni, Cu-Zn-Al and Fe-Mn-Si alloys).

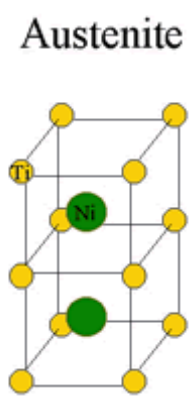
Nitinol has almost equal numbers of Ni and Ti atoms, and phase change temperature can be tuned by slightly varying this ratio.

High-temperature phase: **austenite**, cubic symmetry, rigid
Low-temperature phase: **martensite**, less symmetric, elastic





a, b, & c are not equal,
γ about 96°



CsCl Structure
a = b = c
$\alpha = \beta = \gamma = 90°$

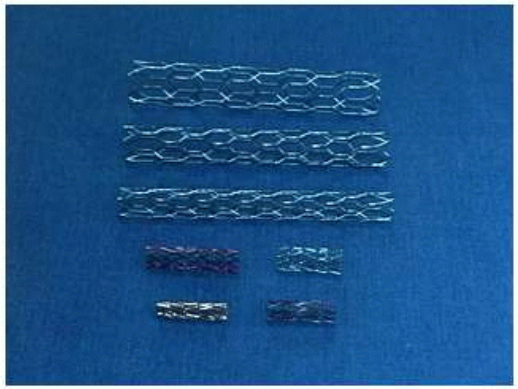
The 24 ways of producing martensite from austenite results from the cubic structure having 6 identical face diagonal planes, each of which can shift in one of two directions and can distort (shear) in one of two directions, 6 x 2 x 2 = 24.

Memory Metals, 2

Memory metals are **superelastic** at certain temperatures, and are used in a variety of applications, due to their ability to return to the initial configuration:

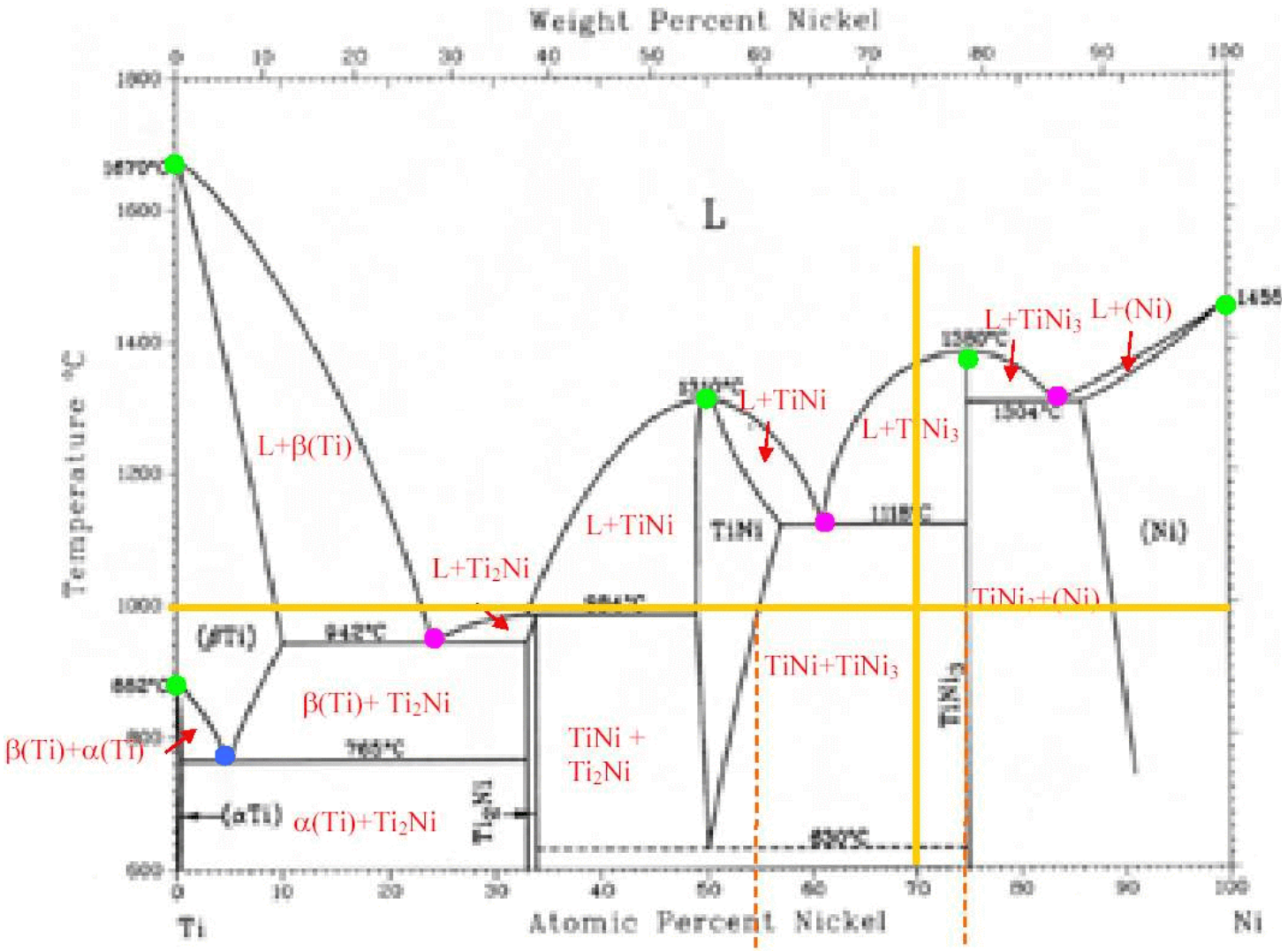
Eyeglass frames
Coffee pot thermostats
Clamps
Deicing systems
Electrical connectors
Sculptures

NiTi alloys are also **biocompatible**, allowing them for use in: vascular stents, anchors for attaching tendons to bone, medical guidewires (e.g., braces), medical guidepins, root canal files, bendable surgical tools, and devices for closing holes in the heart.


NASA and the aeronautics industry currently use the shape memory of NiTi alloys to deploy solar arrays and antennae on satellites, and to control the balance on helicopter rotor blades.

Phase Diagram of NiTi



Phase Diagram of Brass (CuZn)