

Exploring Shape Memory Alloys

Smart Materials

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Shape Memory Alloys

- Shape Memory Alloys (SMA) are novel and special materials
 - They can “remember” their shape when heated above a certain transition temperature
- Also called muscle wires

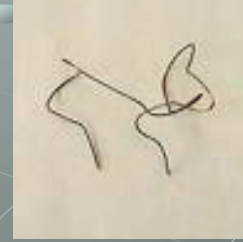


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Shape Memory Alloys

History

- First discovered by Arne Olande in 1938
 - He observed the shape and recovery ability of a gold-cadmium alloy (Au-Cd)
- W.J. Buehler and Wang at the US Naval Ordnance Laboratory 1963
 - observed the shape memory effect in a nickel and titanium alloy, today known as nitinol ("Night in All"; Nickel Titanium Naval Ordnance Lab).



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Shape Memory Alloys

How do they work?

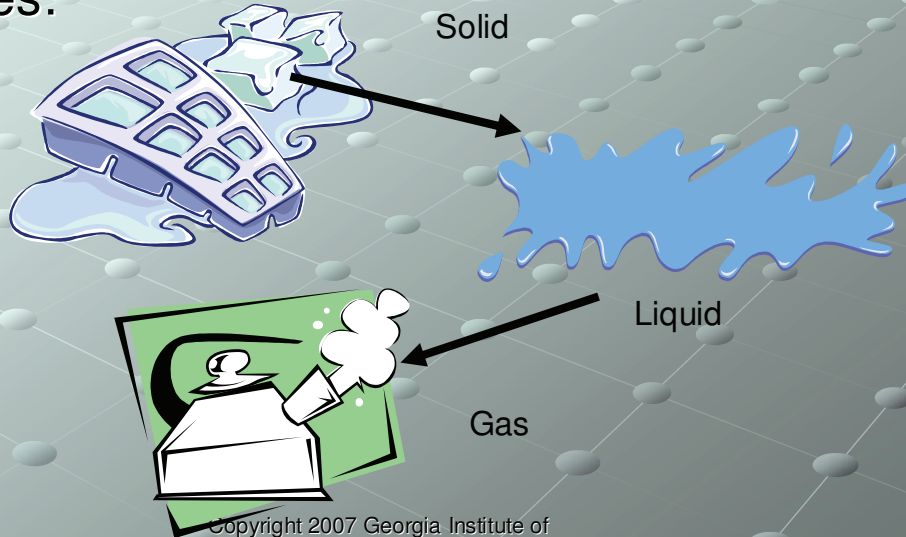
- SMAs change shape based on a solid state phase transformation
- Atomic level changes
 - Rearrangement of atoms
- Change in shape occurs at a specific temperature
 - Shape Memory Effect

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Shape Memory Alloys

How do they work?

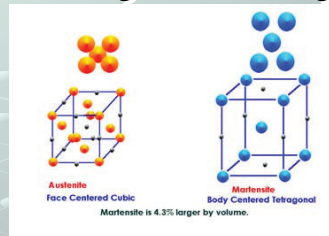
- We all know the most common phase changes:



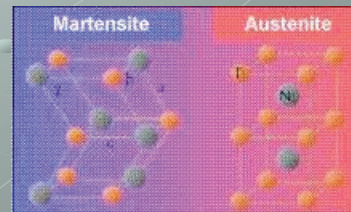
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Shape Memory Alloys

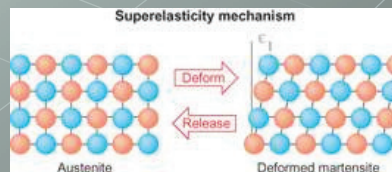
- Nitinol has two phases:
 - High temperature form austenite
 - Very hard and rigid; tight cubic symmetry (how the atoms are packed)
 - Low temperature form martensite
 - Less symmetric, more flexible
 - With pressure, atoms change position. This crystal phase allows the material to be deformed.



www.metal-wear.com/images/ausmart.gif



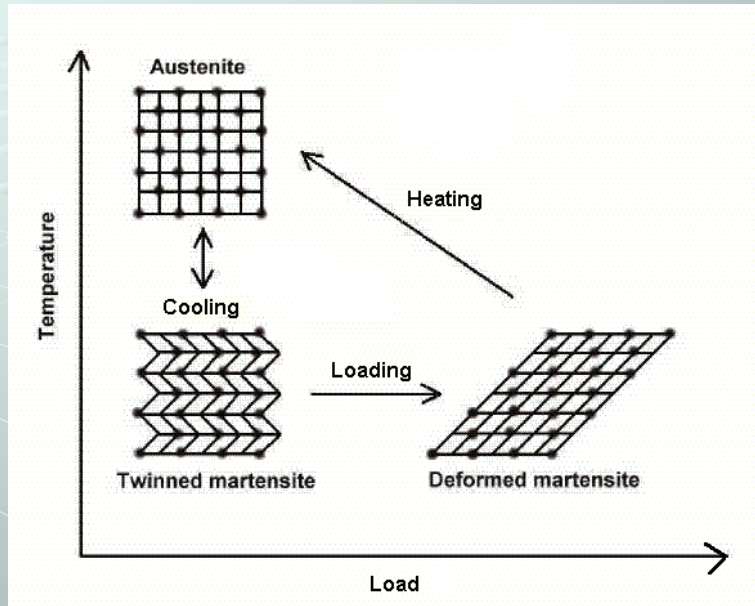
<http://smart.tamu.edu/>



www.c2i2.org/autumn2004/images/Lombardi.gif

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How do they Work?



http://dopamine.chem.umn.edu/chempedia/index.php/Memory_Metals

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Shape Memory Alloys

Muscles are the "engine" that your body uses to propel itself. Although they work differently than a [car engine](#) or an [electric motor](#), muscles do the same thing -- they **turn energy into motion**.



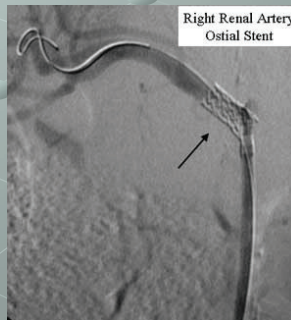
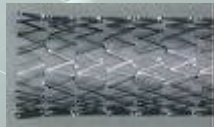
- The solid-state phase change and bounce back effect (pseudo-elasticity) are used to make devices from muscle wires.



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SMA – Medical Applications

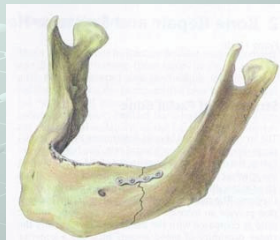
- Stent – a reinforced graft for vascular application to replace or repair damaged arteries (25mm diameter)
- Nitinol stents are used to open arteries that are clogged with plaque.



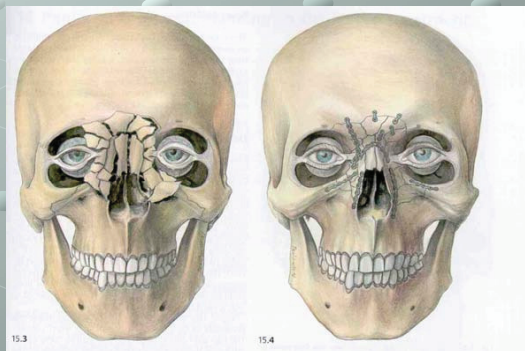
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SMA – Medical Applications

- Bone Plates – Surgical tools to assist healing of broken bones
- Problem – tension reduces & break not under compression
- Bone plates of SMA cooled, inserted, and body temp causes contraction and plate maintains pressure for proper healing



Conventional bone plate used to repair jaw fracture



http://www.cs.ualberta.ca/~database/MEMS/sma_mems/bone.html

A badly fractured face can be reconstructed using SMA bone plates

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Courtesy:

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