# Shape Memory Alloy Actuators

## Loading & bidirectional movement

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# Why We Use Shape Memory Alloy (SMA) Actuators?

- Compact & Lightweight
- High Energy Density
  - Small inputs (like current) generate powerful actuation
  - Mimics muscle-like behavior—great for robotics, wearables.

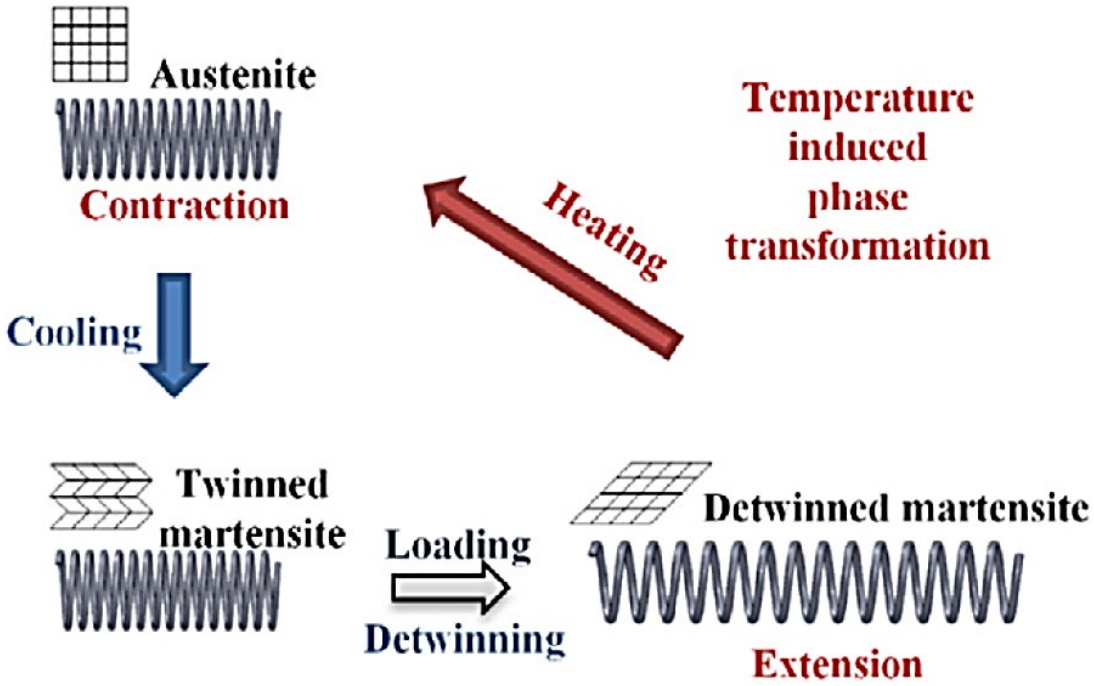
“Smart materials for smart motion”



An, S. M., Ryu, J., Cho, M., & Cho, K. J. (2012). Engineering design framework for a shape memory alloy coil spring actuator using a static two-state model. Smart Materials and Structures, 21(5), 055009.

# SMA properties

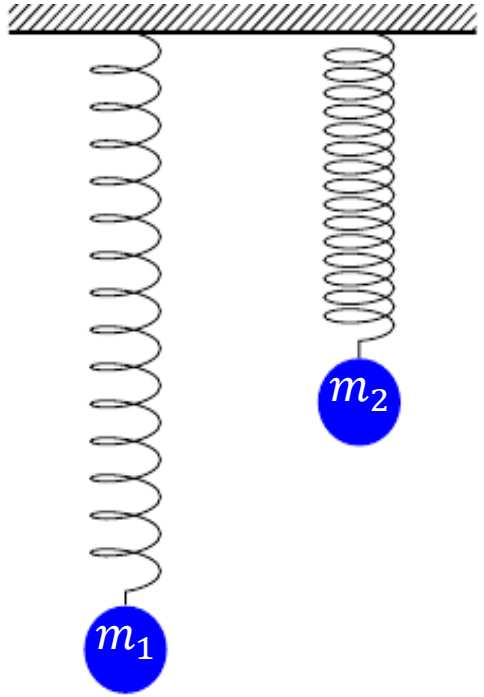
- **SMAs**: Materials that can "**memorize**" a state and/or move in the presence of **stimuli:** heat, electricity, magnetism, light, moisture, or chemical.
- Material has two states: **austenite (A)** – hot and **martensite (M)** – cold.
- Shape transformation occurs with phase transition upon temperature input.



# Smart Materials

**Part 1: Spring SMA actuator loading, you will**

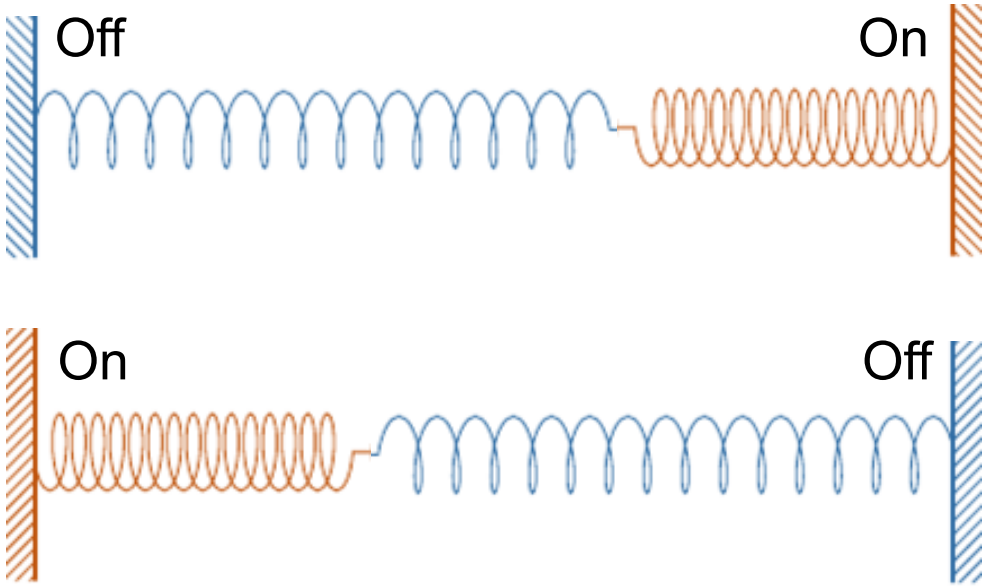
- Learn how to use Arduino to activate linear coil spring SMA actuator.
- Understand force capabilities of spring SMA actuators in terms of stiffness and deflection.



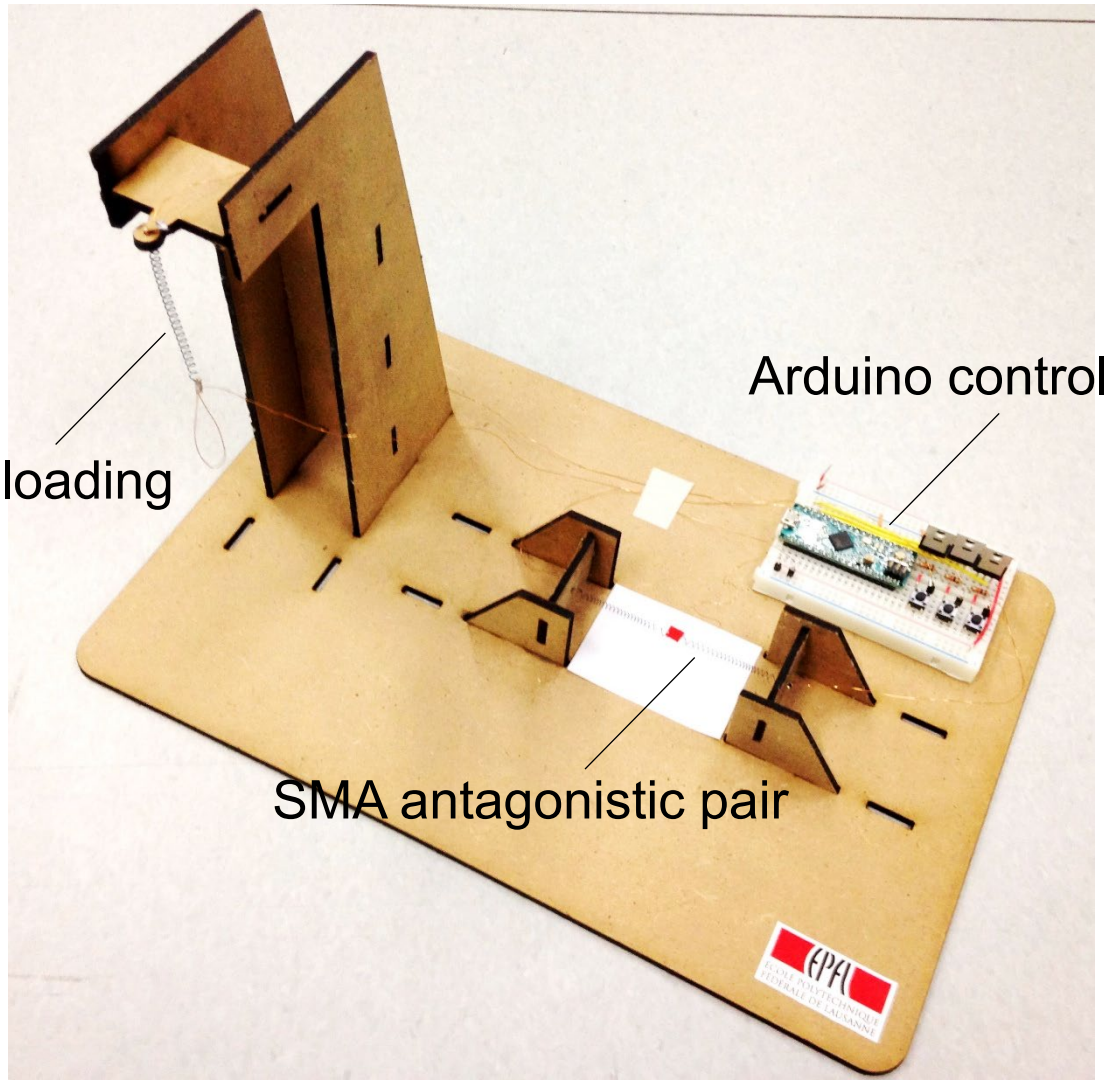
# Smart Materials

**Part 2: Reversible motion with spring SMA actuator. You will**

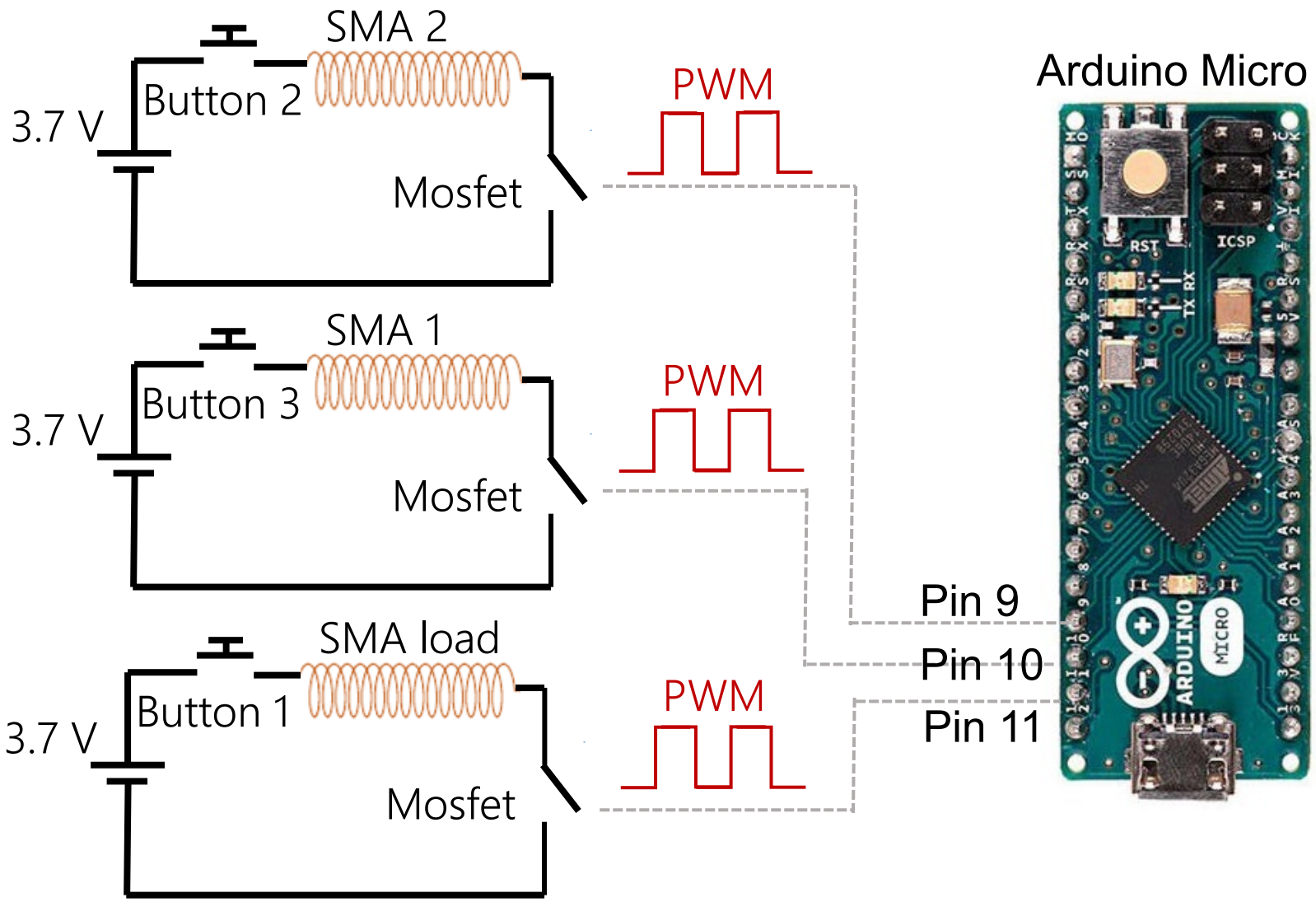
- Learn how to program an Arduino to activate two SMA actuators connected antagonistically.
- Understand bidirectional motion mechanisms using SMA.



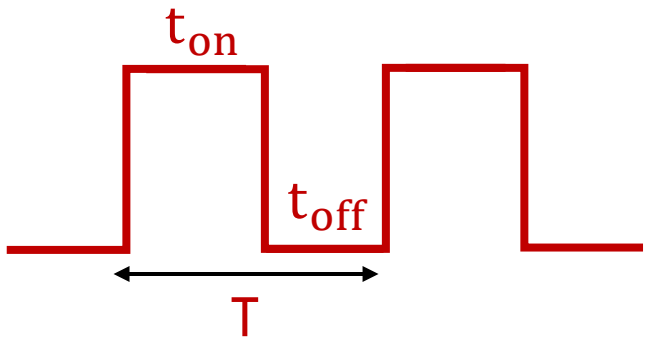
# Setup


SMA for loading
Arduino control board
SMA antagonistic pair

# Circuit Diagram



# Pulse-Width Modulation (PWM)




$$D=(t_{on}/T)\times 100$$

- PWM duty cycle $0\ \% \leq D \leq 100\ \%$
- Arduino Micro PWM has 8 bit resolution: $2^8 = 256$
- Digital representation: $0 \leq D \leq 255$

$$D_{digital} \approx \frac{D}{100} \times 255$$

For ex. 50 % duty = 127

# Questions

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