

SMA Actuator Tutorial

Prof. Carmel Majidi

24-673 Soft Robotics

Overview: These are instructions to fabricate a bending actuator using 0.012” diameter wire of Nitinol shape memory wire. Note that not all nitinol wire exhibits the shape memory effect at room temperature. The wire must have a weight % composition of Nickel and Titanium such that its Austenitic phase transformation temperature is well above 25°C (preferably ~100°C). For this, we use *Flexinol*® wiring from Dynalloy, Inc.

At room temperature, the wire is malleable and can be curved into a circular arc. When attached to a power supply and heated with electrical current, the wire will undergo an Austenitic phase transition and become straight and rigid. If the wire is bonded to a naturally curved elastic substrate, then the wire will bend again after it cools (and reverts back to a twinned-Martensitic phase)

Materials:

- Flexinol® Actuator 0.012” Diameter
- 1 mm thick Acrylic Sheet
- 3M 4950 VHB™ Tape
- 3M F9469PC VHB™ Tape

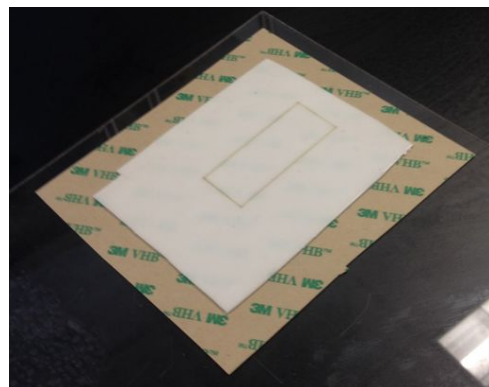
The Flexinol and VHB tape may be purchased from Sparkfun and Digikey, respectively. To fabricate the actuator you will also need scissors, pliers, an Exacto knife, and/or access to a CO₂ laser (e.g. Epilog laser in the MechE Machine Shop). To operate the actuator you will need a 10W power supply.

Instructions:

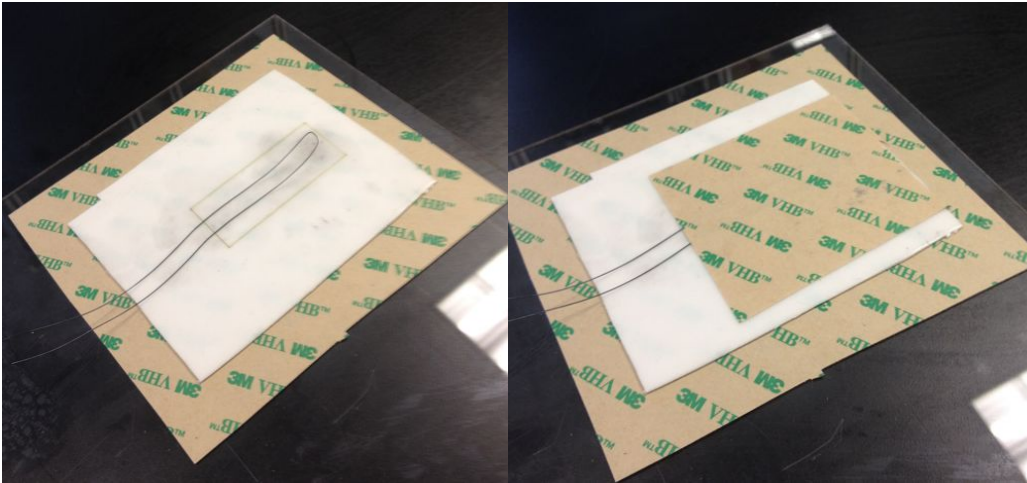
Step 1 – Bond a layer of F9469PC to the Acrylic sheet. Make sure to leave the brown liner film on (labeled with “3M VHB”). This creates a *non-stick* substrate on which to pattern the 4950 foam adhesive.

Step 2 – Cover the non-stick substrate with a sheet of 4950. With an Exacto knife or CO₂ laser, cut the outline of the actuator as shown.

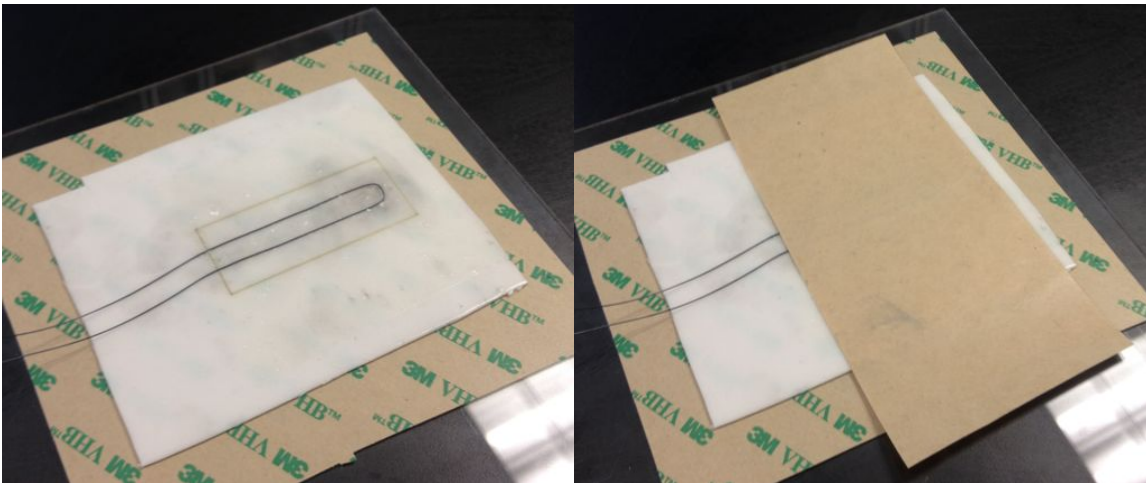
Step 3 – Using pliers, permanently fold or bend the Flexinol wire. It might help to use a vice or crimp tool. Apply enough force so that the deformation is permanent.



Step 4 – Place the wire on the patterned 4950. Flatten it out with a sheet of F9469PC.



Step 5 – After removing the liner on the F9469PC, cover the actuator with a sheet of brown liner film. Leave the bottom edge of the actuator exposed.



Step 6 – Bond an additional layer of 4950 to the bottom edge of the actuator. After peeling off the backing from the 4950, peel it up and remove brown liner. Next, stretch the 4950 and then gently bond it to actuator.

Step 7 – Use a laser or Exacto knife to cut out the outline of the actuator. Remove the excess tape and allow the actuator to spontaneously bend into a circular arc.



Step 8 – To operate the actuator, supply the SMA wire with 1.5-2A of current.

