SPS
Strategic Polymer Sciences, Inc.

# COMPANY PRESENTATION

SPS develops and designs actuator and capacitor solutions based on exclusive Electro-active Polymer (EAP) technology

Your partner for innovative solutions with Electro-active Polymer Technologies

strategicpolymers.com

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COMPANY PROFILE

# Strategic Polymer Sciences, Inc.

SPS Electro-active Polymer (EAP) technology is unique and in many ways superior to competing products. It was developed by an internationally recognized scientist at Penn State University. SPS EAP tecvhnology is recognized to be the optimal solution for novel device applications in many industries, including medical, consumer electronics, defense and energy.

SPS Mission

- Enabling Technology to Improve the Quality of Living
- Bring Innovative and Superior Products into Market

SPS's highly talented team is well balanced between business and technology. Extensive experience in materials sciences, chemistry, and mechanical and electrical engineering combined with hands-on business experience and world-class research skills make the company an invaluable partner.

SPS is well equipped with Clean Rooms, Chemistry Labs, a Prototype Production Line and Machine Shop. The company also has a satellite office in Atherton, CA, which provides SPS and its customers with ready access to the Sillicon Valley techonlogy hub.

SPS Culture and Focus

- Innovation
- Collaboration
- Value Creation

## What Are Electro-active Polymers?

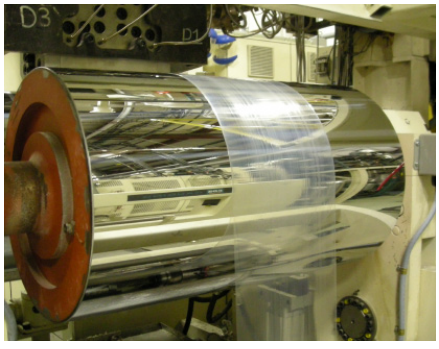
EAPs are polymers that store charge or change shape when an electrical voltage is applied to them.

### EAPs has key benefits over other existing technologies:

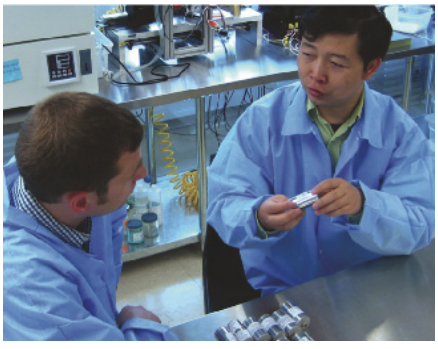
- Store more energy - 4x current technology
- Provide precision mechanical movement up to 100x current technology

### SPS EAP materials are idealy suited for:

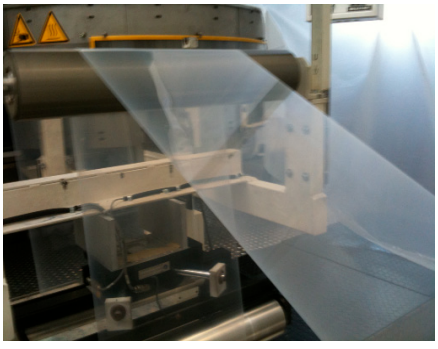
- High energy density capacitors
- High strain actuators
- Solid-state cooling



SPS EAP Film Manufacturing Process



SPS State-of-the-Art R&D Facilities



SPS EAP Film

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EAP ACTUATION TECHNOLOGY

# What makes SPS Electro-active Polymer technology innovative?

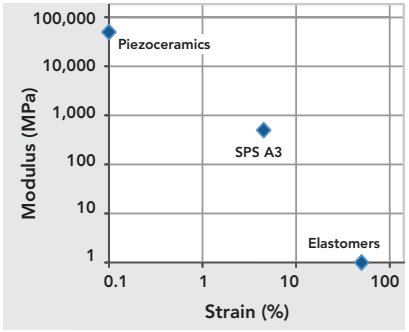
SPS Electro-active Polymer material offers unique qualities that balance the high strain of elastomeric EAPs with the high modulus of piezoceramic materials.

Piezoceramics are only able to actuate on the micron scale,. This strain limitation prevents piezoceramics from being used for large displacement actuations.

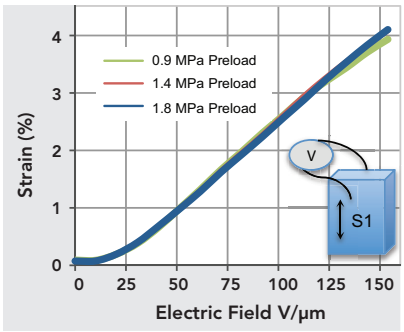
Elastomeric EAPs are limited in their application by their very low modulus and high voltage demands. This low force generation limits them from being used in applications that require compact solutions.

SPS Electro-active Polymer technology is ideally suited for innocative SPS EAP actuators that fill the niche for applications that require modest force generation over short distances. These proprietary actuator designs have low operating voltages and fit design packages where high strain is required and every millimeter counts.

Stress Strain Comparison




Strain Response




Actuator Materials Comparison

| Property | SPS A3 EAP | Elastomer EAP | PZT 5H |
|---|---|---|---|
| Strain | 2.5% (100V/micron) | 5-10% (100V/micron) | 0.1% (2V/micron) |
| Young's Modulus | 700 MPa | 1 MPa | 50,000MPa |
| Dielectric Constant | 45 | 3 | 3500 |
| Dielectric Loss | 5% | 5% | 2% |
| Minimum Film Thickness | 3 microns | 18 microns | 50 microns |
| Drive Voltage @ listed strain and thickness | 300 volts | 1800 volts | 100 volts |
| Operating Temperature | 0-50C | 0-50C | -50-100C |
| Response Time (ms) | <1 | <10 | <0.1 |

## SPS EAP Actuator Attributes:

- Large Displacement: 100 x piezoceramics
- High Force: 100 x elastomers
- Miniaturization / Nano Capabilities
- High Strain Generation
- Lower Operation Voltage
- Fast Response Time

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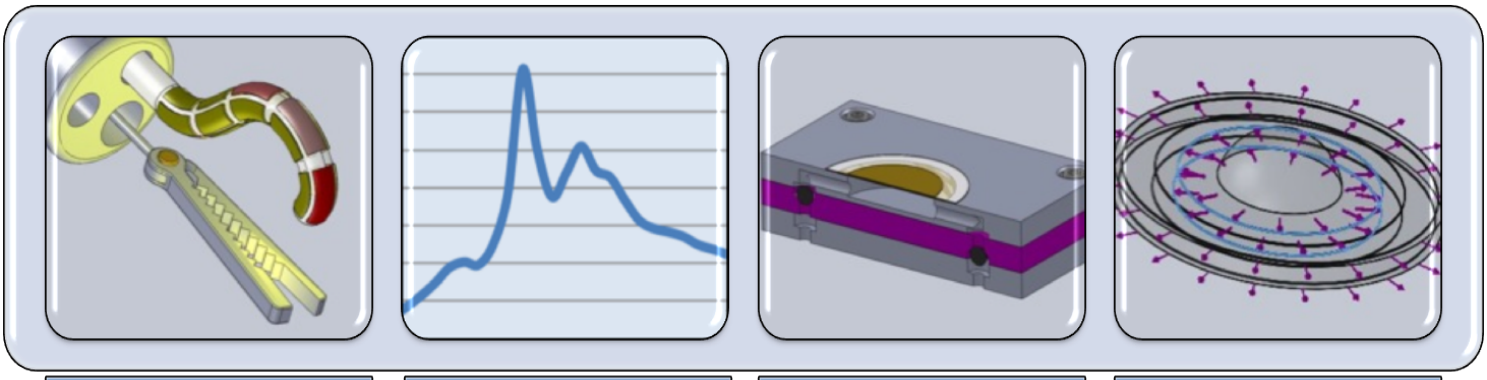
EAP ACTUATOR APPLICATIONS

# SPS Electro-active Polymer actuator applications

SPS Electro-active Polymer technologies both extend the capabilities of existing applications and allow the creation of new products which were not previously possible



## Medical Devices

- Cardiology (Steerable Sheaths, EP Diagnostic and Ablation Catheters)
- Laparoscopy and Minimally Invasive Surgery (Microsteerable Endoscopes)
- Neurointervention (Steerable Microcatheters and Guidewires; Vagus Nerve Stimulation (VNS))

## Haptics/Touch Feedback

- Consumer Electronics (displays, smartphones, media players, e-readers)
- Medical Applications (Medical Robotics, Virtual Training and Simulations and Telesurgery)
- Gaming & Entertainment (Virtual Reality, portable gaming devices, joysticks)
- Assistive technology (Braille pins, Braille glove)

## Micro-fluidics

- Precise micro-scale pumps
- Valves

## Adaptive Optics

- Adaptive lenses
- Auto-focus capabilities
- Wave-front correction

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MEDICAL APPLICATIONS

# Electro-active Polymer technologies for medical applications

As Medical Devices become increasingly smaller, it is a greater challenge to design and develop interventional products that can provide surgeons with tools that can further improve outcomes.

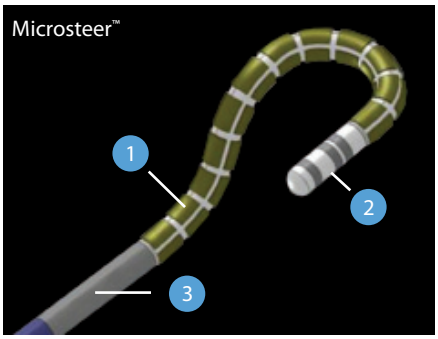
Mechanical actuators such as push-pull wires that can drive steering, deployment mechanisms, and graspers are limited by the French size of the catheter systems. SPS EAP technology offers a novel solution to this problem, where distal actuation is electrically driven through micro wires embedded in the catheter walls. The use of EAP's can provide catheter designers more real estate for a lower profile device.

Traditional mechanical actuators are also limited in their precision by hysteresis. The use of EAP's can provide surgeons with a precise computer-controlled catheter.

Key SPS EAP Catheter Attributes:

- Precisely computer controlled
- No mechanical hysteresis
- Minimal profile for steering element
- 90 degree bi-planar articulation
- More flexibility in shaft designs
- Controlled into complex shapes
- High flow from larger lumens
- Do not require torquing
- Meets target bending and force requirements
- Lower force means soft device to tissue contact

Polymers that change shape when voltage is applied




1. Multiple Degree of Freedom Actuation Technology
2. Standard Ablation Tip
3. Standard Catheter Body

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HAPTIC APPLICATIONS

# SPS Electro-active Polymer actuators deliver high definition haptic feedback

The Electro-active Polymer technologies developed by Strategic Polymer Sciences, Inc. address many of the challenges faced by companies trying to integrate touch feedback interface into their value chain.

Using current actuator choices to create haptic feedback devices are limited by their size, precision control, voltage requirements or force.

SPS EAP actuators balance the high strain of Elastomeric EAPs with the high modulus of Piezoceramic materials and offer unique combination of movement and force to create size and cost efficient haptic solutions.

SPS EAP's have a response time measured in milliseconds and are shown to generate significant levels of acceleration within the haptic frequency band of interest.

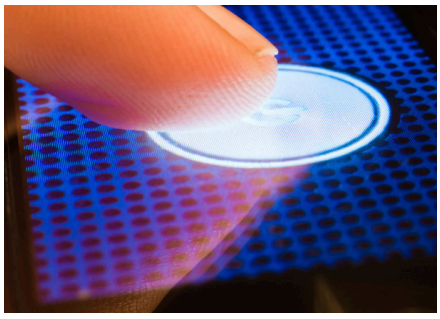
Owing to the relatively low voltages needed to drive the actuator, driving circuits are available in compact and cost effective solutions.

SPS offers expertise in and customization of SPS EAP actuation technology to meet the needs of specific industries in which haptic feedback is applicable:

- Consumer Electronics (displays, GPS systems, smartphones, media players, digital cameras, tablet computers, e-readers)
- Medical Applications (medical robotics, virtual training and simulations, telesurgery)
- Gaming and Entertainment (virtual reality, portable gaming devices, joysticks)

Haptics for Entertainment

Haptics for Medical Applications



Haptics for Consumer Electronics

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EAP CAPACITOR TECHNOLOGY

# High Temperature High Energy Capacitor Film

SPS is developing high-performance capacitor films for electric vehicle, power supply and power conversion applications

- High operating temperature capability
- 2x the dielectric constant of existing materials
- Low dielectric loss
- ½ the size and weight
- Meets US Department of Energy goal requirements

SPS HT Capacitor Properties

| Property | SPS High Tempreture Capacitor Film |
|---|---|
| Dieletric Constant | 4.4 (20 C, 1 KHz) |
| Dielectric Loss | 1% (20 C, 1 KHz) |
| Operating Temp. | -25 - 140 C (Low Duty Cycle) |

## Applications:

Power conversion

Electric vehicle

DC link

Power supplies

Power correction

# High Energy Density Film and Capacitors for Pulsed Power Applications

SPS can deliver film or finished capacitors to meet your application requirements

- Film thickness from 2 to 10 µm
- Existing capacitor designs from 10-120 µF
- Custom film and capacitor design

SPS High K Film Properties

| Property | SPS High K Film |
|---|---|
| Dielectric Constant | 11 (20 C, 1 KHz) |
| Dielectric Loss | 2.5% (20 C, 1 KHz) |
| Operating Temp. | -25 - 85C (Low Duty Cycle) |

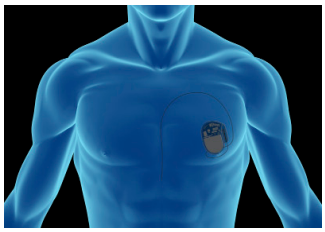
High packaged energy and capacitive densities

- 3-5 J/cm3 @ >1000 volts
- Up to 8 J/cm3 possible

## Applications:

Medical: implantable and external defibrillators

Military: pulsed energy systems (rail gun, aircraft launcher)



Enables more energy in a smaller space

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COLLABORATIVE DEVELOPMENTS

# SPS - your dedicated partner from product design to prototype development and into final production

SPS works collaboratively with industry and universities to develop products utilizing SPS EAP technology. SPS offers expertise and customization to address our customers specific needs and requirements:

- Custom multilayer actuator designs
- EAP films and actuators for collaborative prototype development
- Cutom film and capacitor design
- Prototype fabrication
- Volume Production

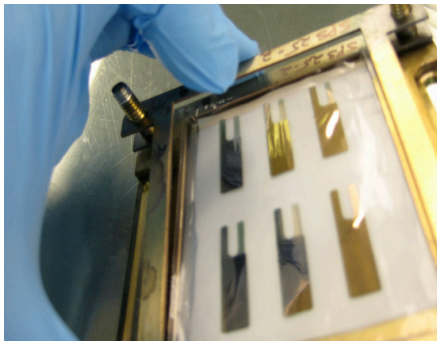
SPS sample kits are available that allow your engineers to evaluate SPS EAP technology proprietary characteristics and their applicability to your devices.

## EAP Actuators for:

- Medical Devices
- Haptic Feedback Applications
- Adaptive Optics
- Microfluidic Pumps
- Force Sensing Applications
- Linear Actuation Mechanisms

## EAP Capacitors for:

- Pulsed Power Applications
- Power Conversion
- Electric Vehicles
- DC Link
- Power Supplies
- Power Correction



Customized EAP Actuator


SPS values its partners

### We value your inquiries

We provide you with direct contact to the innovators creating our technology.

All of our engineers and staff welcome the opportunity to answer your questions, hear about your feedback, and speak with you about yours and ours latest developments.


### Our Location

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