Electro-active Polymers and Their Applications

CIMs has been designing a number of electro-active polymers whose properties are changed

drastically upon stimuli (pH, electric field, light, temperature, etc) with aim on using ther

as a key actuator, sensor and smart window material.

The following is research topics and their applications:

- **Biomimetics and switching technologies**

Acrylamide copolymer, Nafion, Flemion and poly(vinyl alcohol) (PVA) gel

- **Switching window, electromagnetic shutter and display technologies**

Acrylamide and vinyl derivative copolymer, copoly(Aam/vdMG) gel
and electrochromic polymer, ProDOT-(CH_3)

- **Development of Durable Coating Systems for EAP Actuators**

- **Future works**

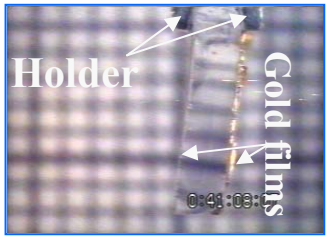
Conducting polymer: polyaniline(PANI) fiber, polypyrrole(PPy) film
and carbon nanotube actuator

Polyvinyl alcohol (PVA) gel

- actuation in electric field by contraction and bending

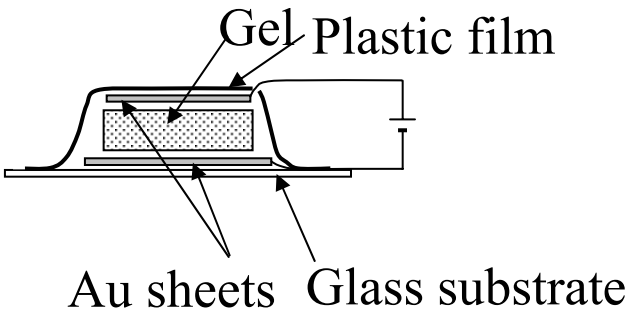
- influence of structure to deformation:
  - molecular level
  - macroscopic level

- fastest response (<1s)
- large deformation (10-20%)
- low strength material
- high applicable voltage

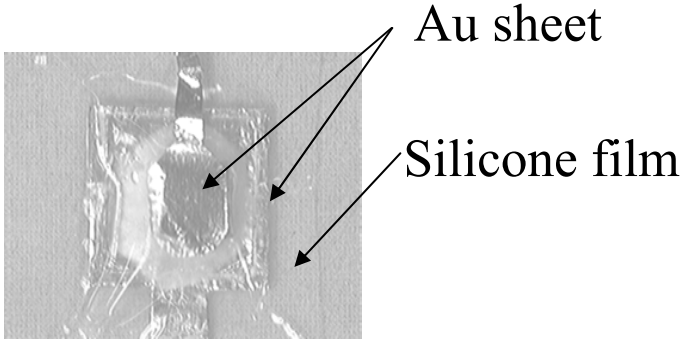


Bending motion
By Dr. T. Hirai and J. Zheng

PVA gel actuator as a switch (using contraction motion)



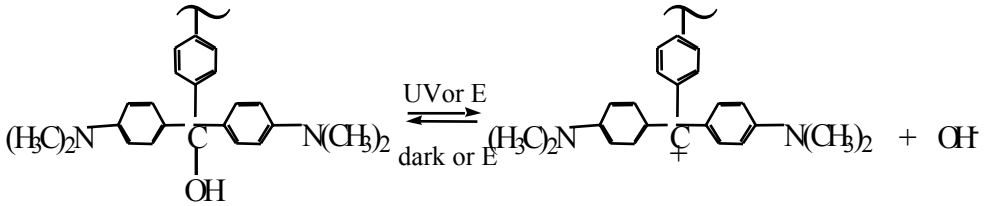
(a) Schematic diagram

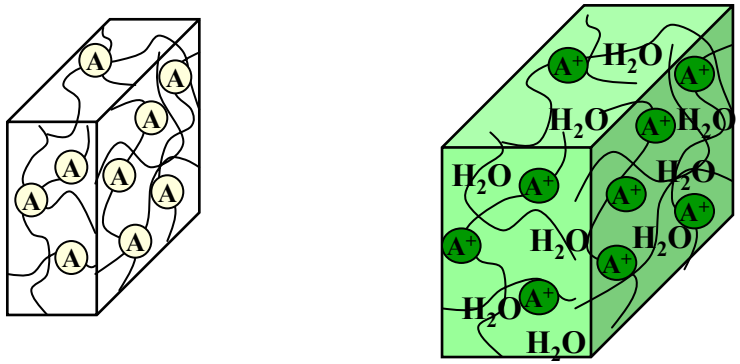


(b) Top view of coated gel

Publication:
S. Popovic, C. Xu, H.Tamagawa, and M. Taya , "Electroactive Non-Ionic Poly(vinyl alcohol) Gel Actuator", Proc.SPIE-The International Society for Optical Engineering, **4329**, pp.238-255, 2001

Color and volume change of copoly(Aam/vdMG) gel





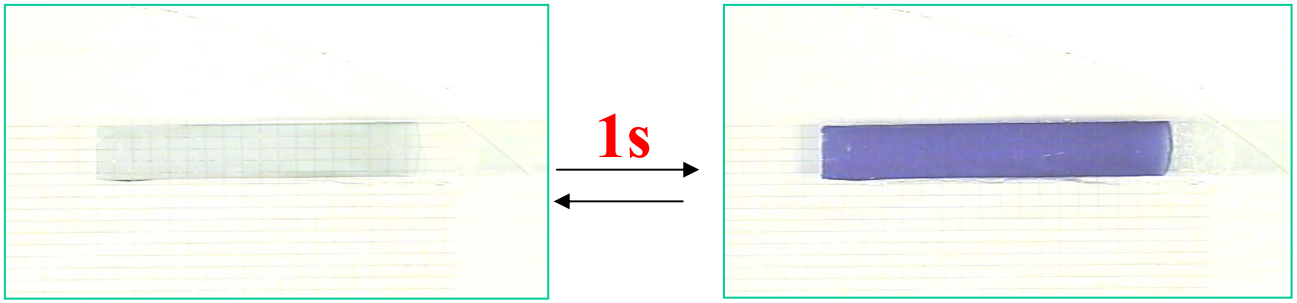
vdMG based EAP whose color reversibly changes from transparent to dark green and from dark green to transparent within 10 s

Changing concentration of vdMG in the gel to control the degree of color change, color changed under E-current, 1.5A,5V at 20 °C

Publication:

C. Xu, H.Tamagawa, M. Uchida, S. Popovic, and M. Taya , "Photo and Electroactive color Changeable Acrylamide Gel Actuator", Proc.SPIE-The International Society for Optical Engineering, **4329**, pp.256-263, 2001

Color Change of EC Polymer Device based on Au patterned Counter-electrode



(a) 2.5V, Transparent

(b) - 2.5V, Dark blue

Potential effects on degree of color change:

0V 1.0V 1.5V 2.0V 2.5V

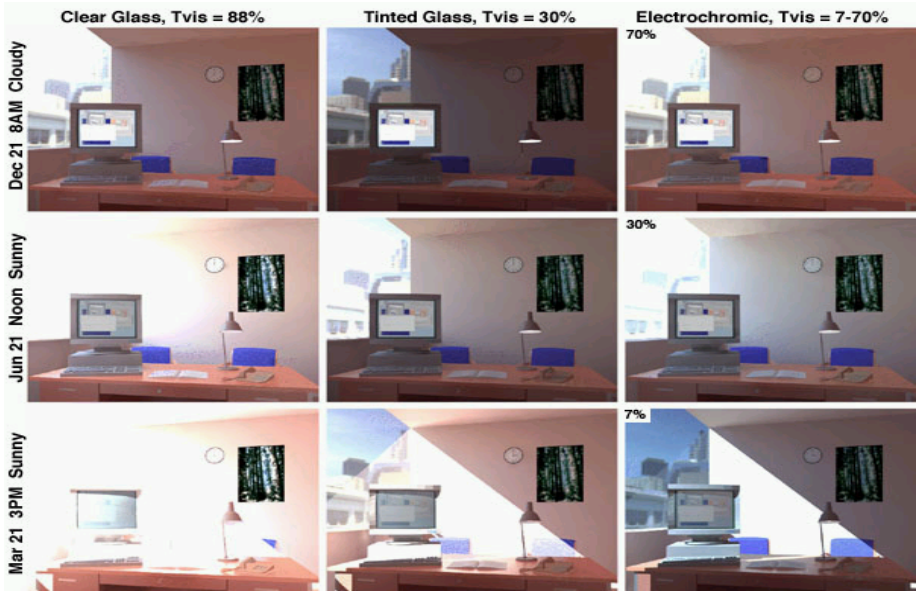
Color changing speed is same, less than 1s

Application Potential

Commercial air plane

Special air craft

(a) *http://www.boeing.com*



(b) *http://windows.lbl.gov*

Smart window for (a) Boeing new generation air plane and (b) building

Publication

C. Xu, H.Tamagawa, M. Uchida and M. Taya
"Enhanced Contrast Ratios and Rapid Switching Color Changeable Devices Based on Poly(3,4-propylenedioxythiophene) Derivative and Au Counterelectrode",
Proc.SPIE-The International Society for Optical Engineering, **4695**, to be published June 21002