SMART MATERIALS

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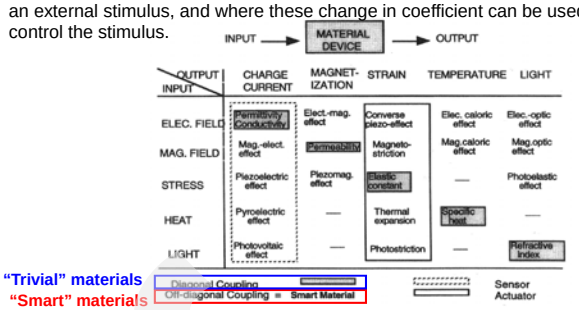
Chapter 1

General introduction on smart materials

1.1 Definition of smartness

(1) Smart materials:

A material which changes one of its property coefficients in response to an external stimulus, and where these change in coefficient can be used to control the stimulus.



Illustration： it combines both sensor and actuator functions

Intelligent materials is the high order of the smart materials

Smart materials, smart structures, adaptive structures, intelligent materials , intelligent structures, …

(2) Motivation for studying smart materials

The concept of creating a higher form of materials and structures by providing the necessary life functions of sensing, actuating, control, and intelligence to those materials.

Smart Materials:
beyond and extend the ability of human beings

TED talk: Play with "Smart Materials"(2012)

1.2 Types of smart materials

Smart materials can be subdivided based on their response modes:

- Passively smart materials

  that respond to external change without assistance.

  Highly nonlinear effect

- Actively smart materials

  that utilize a feedback loop enabling them to both recognize the change and initiate an appropriate response through an actuator circuit.

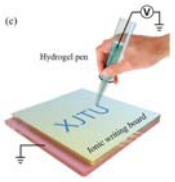
  sensing and actuating

Smart materials based on the external stimulus:

In a scientific way, external stimulus to a material includes electric, magnetic, mechanical, thermal, light, …

Electrochromic materials

Which change their color or opacity (how much light they let through) on the application of a voltage.

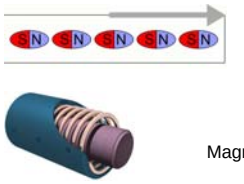


Electric → Color

Also: Electroluminescence (liquid crystal display)

Magnetostrictive materials

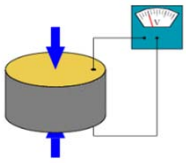
Deform when applied magnetic field.



Magnetic → shape (magnetic dipole)

Piezoelectric Materials

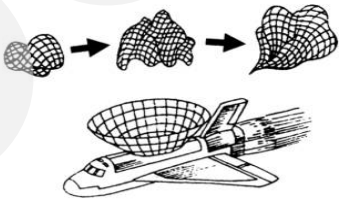
Generate electric signals when applied force, or vice versa.



Mechanical → Charge (Electric dipole)

Shape memory materials

Memorize its original shape when temperature changes.



Thermal → Strain

Photovoltaic Materials

Photovoltaics (PV) is a method of generating electrical power by converting solar radiation into direct current electricity using semiconductors that exhibit the photovoltaic effect.

Light → Electron, hole

Rheological Materials

These materials can change from liquid to solid when an electrical current or magnetic field is applied.

Electric or Magnetic → Viscosity change

Contents of our course

Basic and major smart materials：

Piezoelectric materials	***E, σ, T***
Shape memory materials	***T, σ, E***
Magnetostrictive materials	***H, E***

Shape Memory Alloys:
Arguably the first smart materials
Shape memory metals/ceramics/ polymers

Electro-ceramics:
Electrical as input or output signals
A huge potential in future applications