

Lahore College for Women University Lahore





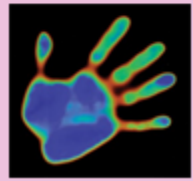




Lecture:14

Course: Nanotechnology & Nanostructures

Instructor: Dr. Zohra Kayani

Smart Materials

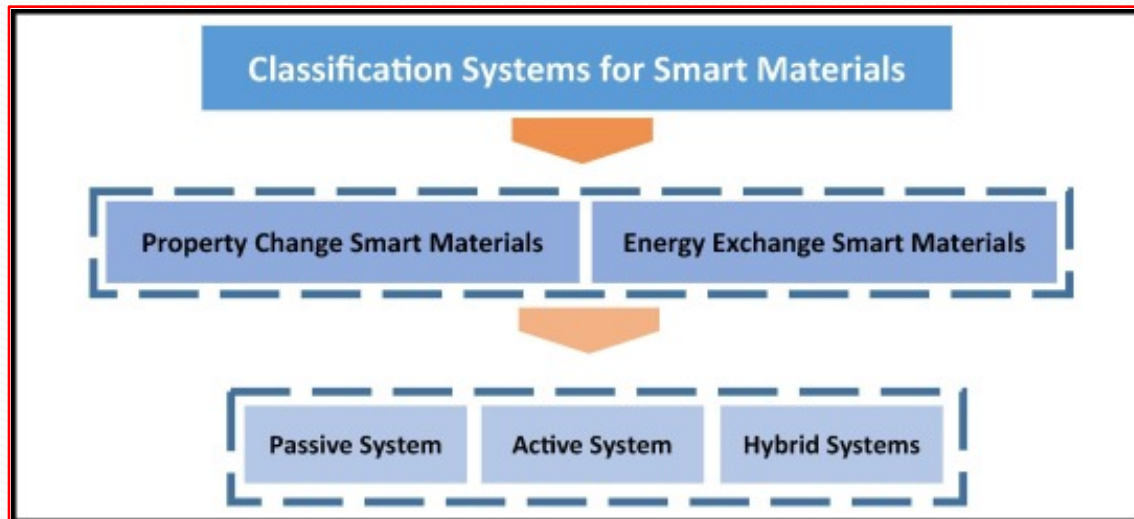
<h2>Smart Materials</h2>	<p>Photochromic</p>  <p>An illustration of a pair of glasses with a photochromic lens. Above the glasses are icons for a cloudy day, a sunny day, and a moon, indicating the lens's ability to change opacity in response to light. A red double-headed arrow below the glasses indicates the reversible nature of the process.</p>	
<p>Micro-encapsulation</p>  <p>A diagram showing two spherical particles. The left particle is a core-shell structure. An arrow labeled "TRIGGERED RELEASE" points to the right particle, where the core is shown being released from the shell.</p>	<p>Polymorph</p>  <p>A photograph showing a person's hands holding a small glass jar. The person is pouring a white, crystalline substance from the jar onto a white adhesive bandage.</p>	<p>Piezoelectric</p>  <p>An illustration of a piezoelectric material, showing a circular disc with a wire connected to it, and a curved wire extending from the disc.</p>
<p>Thermo-chromic</p>  <p>A photograph of a hand with a thermo-chromic material applied to it. The material is a blue and green liquid that changes color when exposed to heat, as shown by the red and yellow areas on the hand.</p>	<p>Quantum Tunnelling Composite</p>  <p>An illustration of two blue, starburst-like structures representing quantum tunnelling composites.</p>	<p>Shape Memory Alloy</p>  <p>A photograph of a hand holding a pair of glasses. The glasses are made of a shape memory alloy, which is shown in its original shape.</p>

Smart Materials

- A number of materials have an apparent ability to **change one or more of their properties in response to the input from an outside source.**
- A variety of reactions or processes and phase changes may take place internally in a material as a consequence of the input signal from an external source that in turn alters the material's properties.

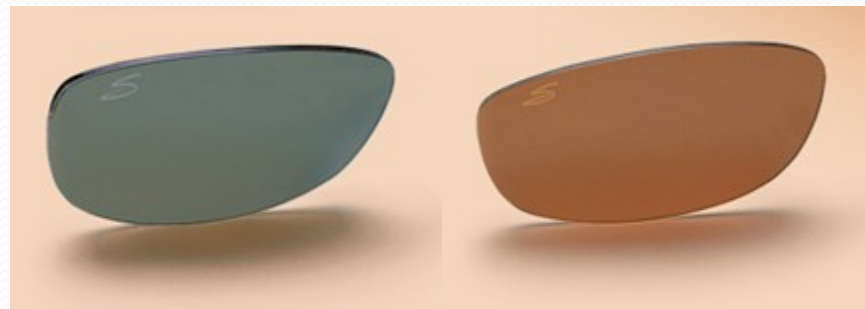
Classification of Smart Materials

- There are **two** different types of smart materials.
 1. **Type I**
 2. **Type II**



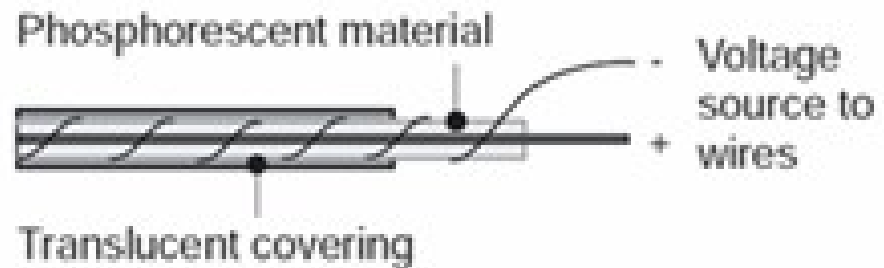
Type I-Smart Materials- Property Changing

- In these smart materials, there is an **apparent change** in certain properties of the material such as **changes in optical properties** that result in color changes.
- For example, **thermochromics** change their apparent color as the temperature of their surrounding environment increases and there is an input of thermal energy into the material.



Type II

- The smart material subjected to **the input of one energy type changes it into another energy** type as a consequence of induced internal actions and thus there is an **“energy-exchanging”** behavior.
- For example, in a common piezoelectric material, the input of mechanical energy causes an electrical energy output, or vice versa.

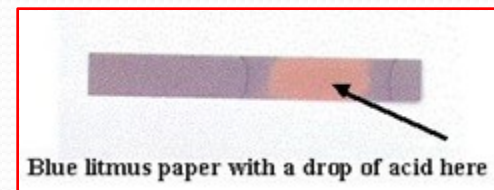
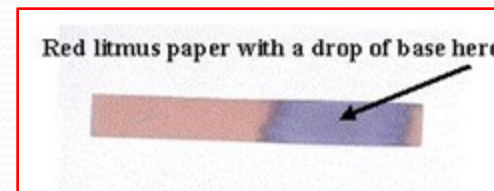


Electroluminescent wire

TYPE OF SMART MATERIAL	INPUT	OUTPUT
Type 1 Property-changing		
Thermochromics	Temperature difference	Color change
Photochromics	Radiation (Light)	Color change
Mechanochromics	Deformation	Color change
Chemochromics	Chemical concentration	Color change
Electrochromics	Electric potential difference	Color change
Electrorheological	Electric potential difference	Stiffness/viscosity change
Magnetorheological	Electric potential difference	Stiffness/viscosity change
Type 2 Energy-exchanging		
Electroluminescents	Electric potential difference	Light
Photoluminescents	Radiation	Light
Chemoluminescents	Chemical concentration	Light
Thermoluminescents	Temperature difference	Light
Light-emitting diodes	Electric potential difference	Light
Photovoltaics	Radiation (Light)	Electric potential difference
Type 2 Energy-exchanging (reversible)		
Piezoelectric	Deformation	↔ Electric potential difference
Pyroelectric	Temperature difference	↔ Electric potential difference
Thermoelectric	Temperature difference	↔ Electric potential difference
Electrorestrictive	Electric potential difference	↔ Deformation
Magnetorestrictive	Magnetic field	↔ Deformation

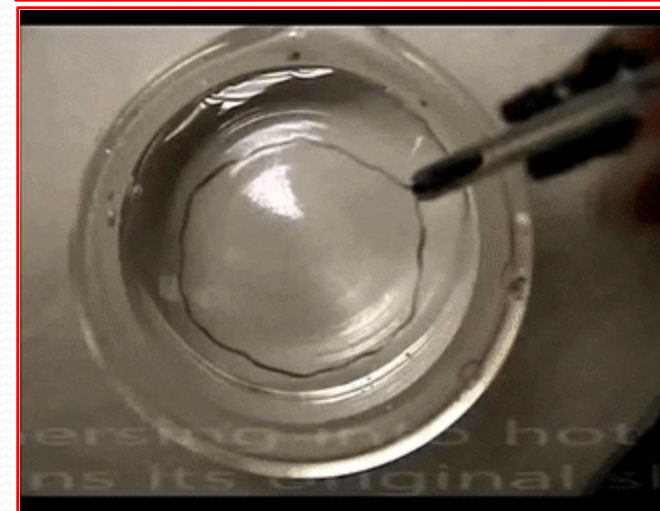
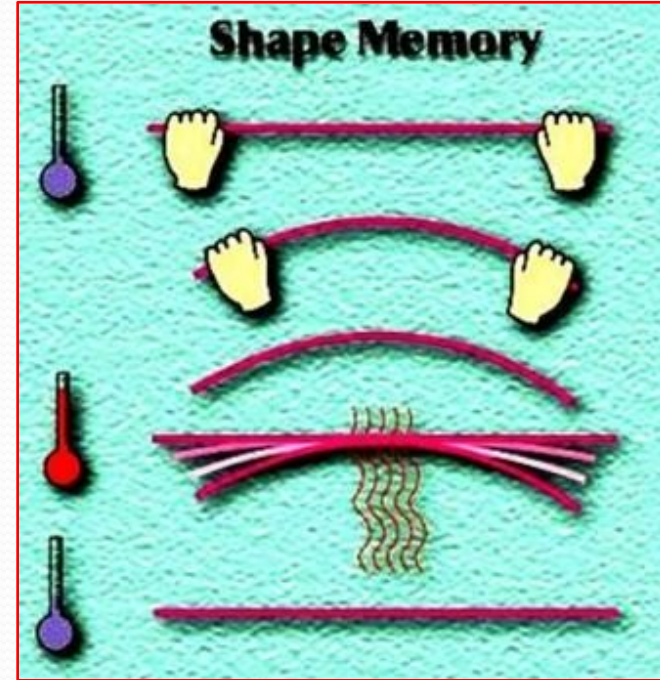
Colour Changing Property

- The apparent ability of a material to change color is a **light-related characteristic**.
- Many existing “smart materials” have this characteristic, including **thermochromics**, **photochromics**, **chemochromics**, and **mechanochromics**. In all these materials, input of one form or another of external energy causes an apparent color change in the material.



Shape Changing Property

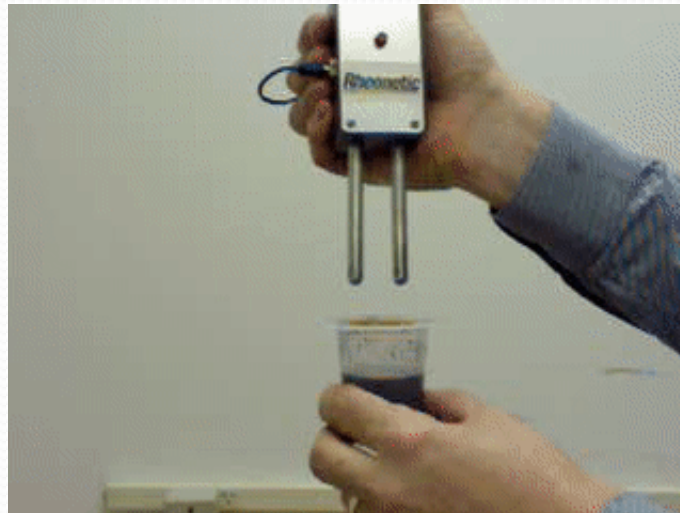
- There are few materials that exhibit “memory”. If a piece of material with “shape-memory alloy” is deformed from an initial shape into a new shape, it will remain in the new shape. When heated to a certain critical temperature, the material will literally go back to its initial shape without mechanical aid. The material “remembers” its original shape and returns to it. The heat can be directly applied or come via an electric current.
- Materials such as **TiNi** have been developed for this purpose.



Varying Electric, Magnetic and Other Properties

- The smart materials may have ability to change its **electrical resistance**, its **magnetic properties**, its **stiffness**, or even its **shape** via the input of some energy source. Smart materials possess one or more of these qualities. For examples:
- A **magnetorheological fluid** changes its **rheological properties (its viscosity and stiffness)** as the surrounding **magnetic** environment varies.
- An **electrorheological fluid** changes its **rheological properties (its viscosity and stiffness)** in response to an **electric** current.

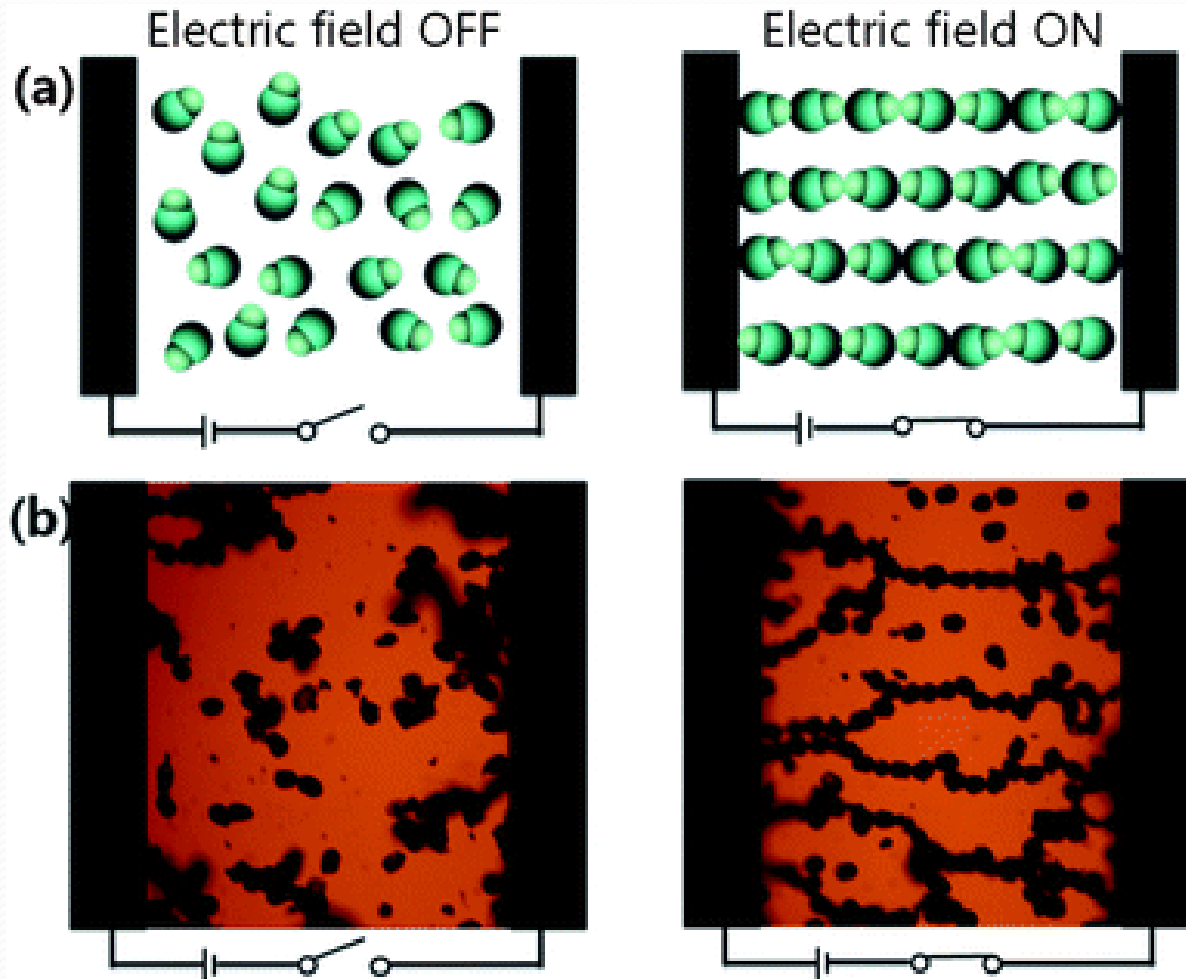
- These kinds of fluids are generally “structured fluids” that contain colloidal dispersions that change phase when subjected to a magnetic or electrical field. These materials can transform from a very fluid state to a highly viscous state due to the changes in the electrical or magnetic environment.
- These materials have been used in automotive clutches as parts of power transfer devices.



Magnetorheological Fluid



Electrorheological fluid



Smart skins and envelopes

- In developing various kinds of surface structures (skins, coverings or envelopes) that exhibit smart behavior “**multifunctional**” surfaces are focused.
- These surfaces might include functions varying from **antibacterial to self-repairing** and others.
- The **smart sensor/actuator systems** respond to a variety of **stimuli** and they are in turn linked to a comprehensive control/logic system.

Electronic Tattoo turns skin into display





**It has a smart sensor
that detects when your
hand is underneath it**



Thank You