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Smart Materials

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Abstract: *Smart materials are now days being used in all spheres of human life and technology. A lot of research is going on to utilize their potential in various engineering application which make prove useful for common people. A wide variety of smart materials exist which includes piezoelectric materials, magneto rheological materials (MR), electro rheological materials (ER), shape memory alloys, etc. in both ER and MR fluids, the change in fluid properties like viscosity can be manipulated by varying an electric supply, by varying the strength of the electric field, the particle change can be aligned in between the electrodes. The automotive and aerospace industries have for the first time used these smart materials for various application. These papers highlights the application of smart materials.[1]*

Keywords: *Smart materials, Piezoelectric, Electro rheological and magneto rheological fluids.*

I. Introduction

Smart or intelligent materials are material that has to respond to stimuli and environmental changes and to activate their function according these changes.

The stimuli like a temperature, pressure, electric flow, magnetic flow, light, mechanical , etc can originate internally or externally.

Smart materials and related technologies have been drawing an increasing amount of attention from researchers in related fields worldwide. In the past decade, smart materials and structures has been one of the most progressive fields of research. Recently developed materials and devices have been used to address many challenges in aerospace, mechanical, bionics and medical technologies. The progress made in developing advanced materials and devices is impressive and encouraging.

The theme of this special section is smart actuators and applications. This is one of the research areas of smart materials and structures that is recognized as an essential aspect of smart technologies. Therefore, we have organized this special section to promote the development of technology as well as international communication in this field. In the section, current progress in the field of smart materials and structures is presented. The papers published cover the most recent research results in the development of several different kinds of smart materials (e.g. fiber-reinforced shape memory polymer composites, electro-rheological fluids, electro-active papers, shape memory alloys etc)[2]. In addition, applications of the materials in smart structures are also included. We believe that the papers published in this special section will be found to provide the latest information and will encourage more researchers to make their contribution to this field of research.

II. Properties Of Smart Materials

- Sensing material and devices.
- Actuation materials and devices.
- Control devices and techniques.
- Self detection, self diagnostic.
- Self corrective, self controlled, self healing.
- Shock absorber arrest.[3].

III. Compents Of Smart System

3.1 Data acquisition (tactile sensing): The aim of this component is to collect the raw data needed for an appropriate sensing and monitoring of the structure. e.g. fiber optic sensing.

3.2 Data transmission (sensory nerves): The purpose of these parts is to forward the raw data to the local and or central command and control units.[2].

3.3 Command and control unit (brain): The role of these unit is to manage and control the whole system by analyzing the data reaching the appropriate conclusion and determining the actions requires.

3.4 Data instruction (motor nerves): The function of these part is to transmit the decisions and the associated instructions back to the member of the structure .

3.5 Action devices (muscles): The purpose of these part is too take action by triggering the controlling devices/units.[4]

IV. Classification Of Smart Material

4.1 Piezoelectric materials**:** when subjected to an electric charge or variation in voltage, piezoelectric material will undergo some mechanical change, and vice versa. These events are called the direct and converse effects.[3]

4.2 Electrostrictive materials : These material as the same properties as piezoelectric material, but the mechanical change is proportional to the square of the electric field. These characteristic will always produce displacements in the same direction.[3]

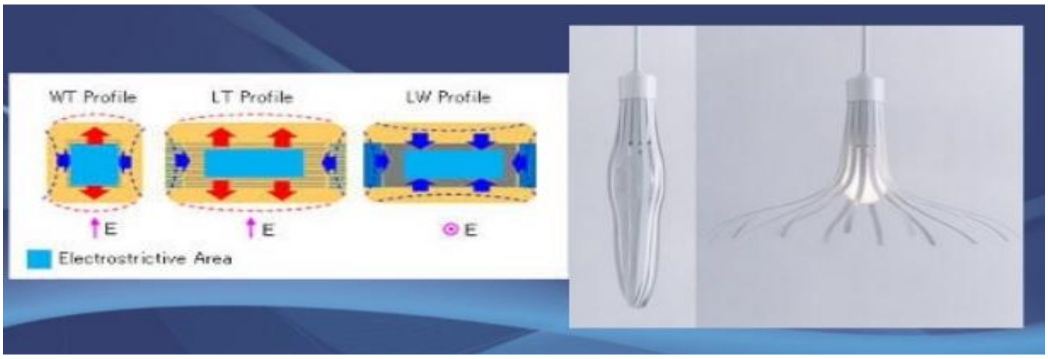

Fig.1. Electrostrictive materials

4.3 Magnetostrictive materials : when subjected to a magnetic field, and vice versa, these material will undergo and induced mechanical strain .consequently, it can be used as a sensors and actuators. (e.g. terrifnol)

Fig. 2. Magnetostrictive materials

4.4 Rheological materials: These are in liquid phase which can change state instantly through the application of an electric or magnetic charge. These fluids may find application in brakes, shock absorber and damper for vehicle seats.

4.5 Thermoresponsive material: Thermoresponsive is the ability of the material to change properties in response to changes in temperature. They are useful in thermostat and parts of automotive and air vehicles.

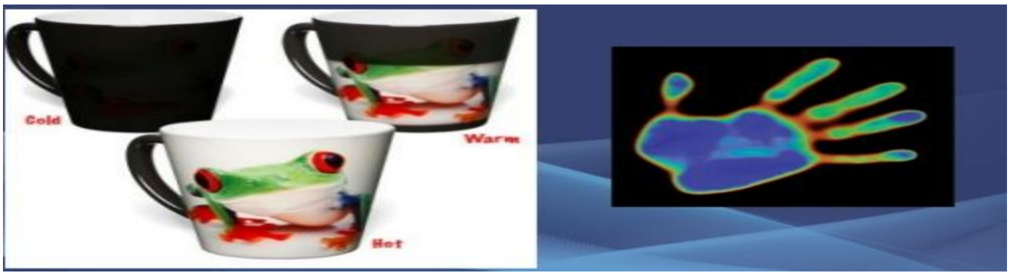

Fig. 3. Thermoresponsive material

4.6 Electrochromic materials: Electrochromic is the ability of material to change its optical properties.(e.g.color) when voltage is applies across it they are used in LCDs and cathode in lithium batteries.[3]

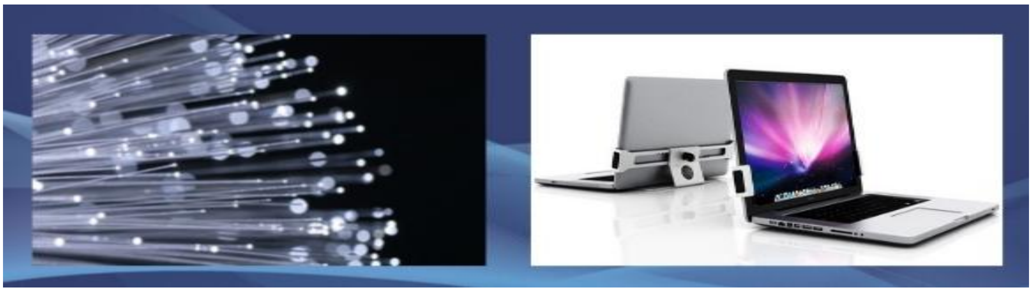

Fig. 4. Electrochromic material

4.7 Fullerences : These are spherically caged molecules with carbon atoms at the corner of polyhedral structure consisting of pentagons and hexagons. These are usually used in polymeric metrices for used in smart systems. They are used in electronic and microelectronic devices.[3]

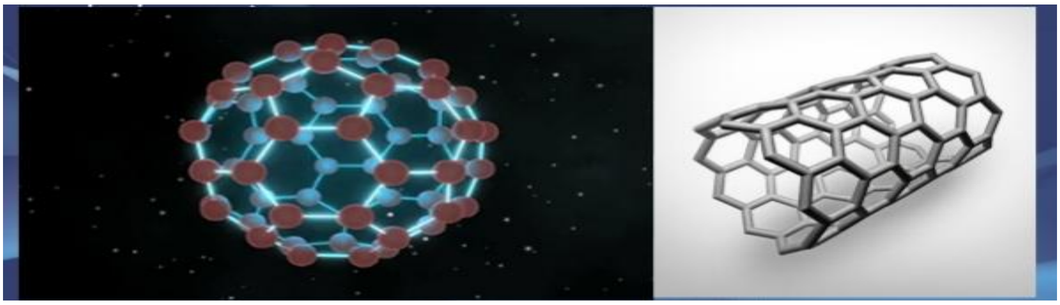

Fig. 5. Fullerences

4.8 Biomimetic materials : The material and structure involved in natural systems have the capability to sense their environment, process the data and respond instantly.

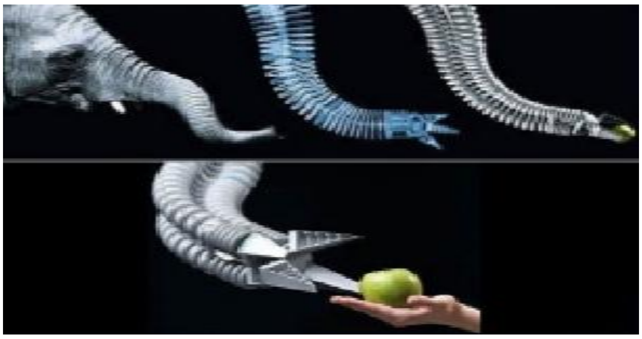

Fig. 6. Biomimetic materials

4.9 Smart gels: These are the gels that can shrink or swell by several order of magnitude. Some of these can also be programmed to absorb release fluids in response to a chemical or physical Stimulus. These gels are used in areas such as food, drug delivery.[3]

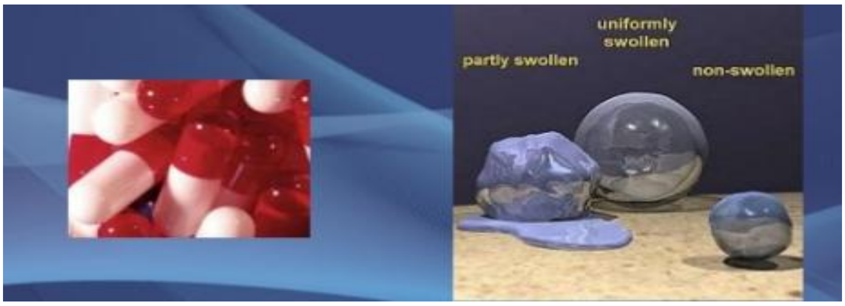

Fig. 7. Smart gels

V. Working Of Smart Material

5.1 Two phases are:[2]
5.1.1 Martensite to austenite transformation occurs by heating.
5.1.2 Austenite to martensite occurs by cooling .

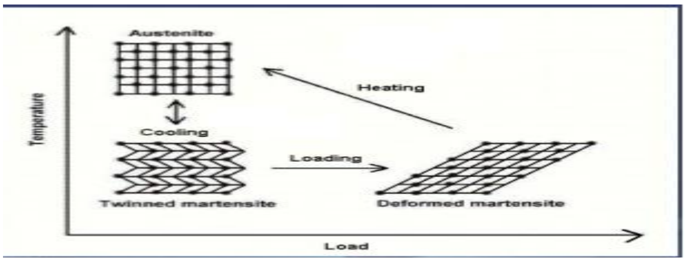

Fig. 8. Martensite to austenite and Austinite to martensite.

5.2. Shape memory alloys :

In 1930s, Arne Olander was first observed the shape memory effect while working with an alloy of gold and cadmium. This Au-Cd alloy was plastically deformed when cold but return to its original configuration when heated. The shape memory properties of nickel titanium alloys where discovered in the early 1960s. Although pure nickel titanium has very low ductility in the martensitic phase, the properties can be modified by the addition of a small amount of a third element. These groups of alloys are known as Nitinol (Nickel- titanium-naval- ordnance- laboratory).[4]

- Martensite * Deforming martensite * Deformed martensite * Austenite *Martensite

5.3 Thermal Hysterisis

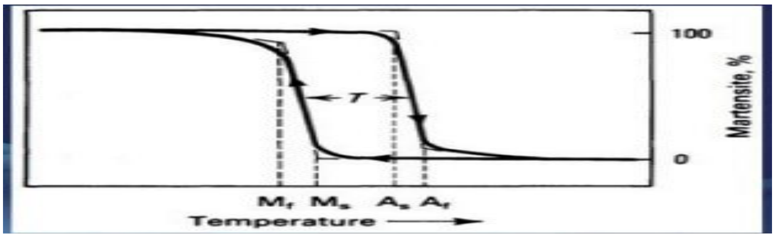

Fig. 9. Thermal Hysteresis

Where,

- M(s) – Martensite start * M(f) – martensite finish * A(s) – Austenite start
- A(f) – Austenite finish.[2]

VI. Application

- Aircrafts
- Orthopedic surgery
- Dental braces
- Robotics
- Reducing vibration of helicopter blades.
- Smart fabrics
- Sporting goods
- Smart glass

VII. Merits And Demerits

7.1 Merits:

- Bio-compatibility
- Simplicity
- Compactness
- Safety mechanism
- Good mechanical properties

7.2 Demerits:

- More expensive

- Low energy efficiency
- Complex control
- Limited bandwidth[4]

VIII. Conclusion

Today, the most promising technologies for lifetime efficiency and improve reliability include the use of small material and structures. Understanding and controlling the composition and microstructure of any new material are the ultimate objectives of research in these fields, and is crucial to the production of good smart materials. New and advanced material will definitely enhanced our quality of our life.[1]

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References

[1]. Akhras, G., “Smart Structures and their Applications in Civil Engineering”, Civil Engineering Report, CE97-2, RMC, Kingston, Ontario, Canada, 1997.

[2]. Culshaw, B., Smart Structures and Materials, Artech House Inc, 1996 and Bank, H. T., Smith, R.C. and Wang, Y., Smart Material Structures, Modeling, Estimating and Control, John Wiley and Sons, 1996

[3]. Dufault, F. and Akhras, G., “Applications of Smart Materials and Structures in Bridge Construction”, Proceedings, 3rd CanSmart Workshop on Smart Materials and Structures, Sep. 2000, pp. 149-159.

[4]. Akhras, G., Editor, *Proceedings,* CanSmart Workshops on Smart Materials and Structures, St-Hubert, Quebec, Canada, Sep. 1998 and Sep. 1999.