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Review on applications of Smart Materials

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Abstract: *Smart materials are stimuli reactant, environment based changes occurs in them and can be used for behavioral changes due to various reasons. These materials can have numerous applications. The smart word itself gives us idea about how intelligent a material can be when it comes to environmental and stimuli based changes*
Keywords- *Smart materials, Stimuli based, Intelligent*

I. INTRODUCTION

Human being from thousand years ago used material for different purposes, which enhanced their life styles, even civilization was classified by different ages that started by discovering a new effective material. According to archaeologists, the first age belongs to Stone Age, and a most revolutionary fall out with discovery of bronze, because it was harder and durable than the other on hand materials. The Bronze Age was the beginning of metallurgy, which civilization steps further to extract different materials that occupied every part of our life. In the last two centuries, dense researches have been done to synthesize new types of functional materials, which are classified to several groups and families. There are four main group of materials which are metals, ceramics, polymers, and recently advanced materials. Among them, advanced materials become more attractive one because they have more technological applications. Since, some physical properties of advanced materials can be controlled; they are the building block of most advanced hybrid devices around us. Semiconductors revolve generation of computers from vacuum tubes to a more compacted electronic chips. On the other hand, biomaterials opened the way of interaction with biological organs, likewise nano-engineered materials are more efficient than their bulky counterparts. Consequently, smart or intelligent materials will boom civil engineering, industrial appliances, medical instruments, automation systems and more. Nowadays, the necessity of using smart materials for various constructions are due to their ability to change properties when exposed to external stimuli. Their reversibility makes them to be one of the matchless materials and can be specified by their sensing, healing and adaptable in response to environmental conditions. Factors like, temperature, mechanical stress, strain, hydrostatic pressure, magnetic field, electric current, pH or chemical effect, can lead to a change in size, color, moisture, scent, and viscosity of flow . Thus, the smart material's applications such as sensors, actuators and drug delivery can be satisfied by using the aforementioned parameters. In this review, we have concentrated on an introduction to different types of SMs and their potential applications in various areas. This article has been arranged such that the SMs defined in chapter two and from a historical point of view; the most important investigations and discoveries were illustrated. Since, SMs have different types, then their groups were counted and some important physical properties have been explained in chapter three. In addition, for showing their important situation in modern society, some of recent applications were represented in chapter four. Finally, some active field of research and open gates were clarified that may give opportunity to the researchers in this area.

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II. SMART MATERIALS

There is not a unique definition for smart materials], e.g. NASA defined them as materials that can remember different forms and able to reconcile with particular stimuli, or it can be defined as a highly engineered materials which can react smartly to their environment .Smart materials belong to advanced material that can sense some particular signals from outside and actuating themselves to doing a determined task. Smart, intelligent, or even adaptive are the words that are used for those materials, which are including sensors and actuators. In

addition, they have some features that make them to be distinguished from the other materials, such as Transiency: they can respond to different stimuli and can be situated in varies states; Immediacy: they response to the external effects without wasting time; Self-actuation (intelligence): this ability is inside the mater; Selectivity: the response is distinguished and predictable; Directness: both act and react are accrued in the same place. Smart materials are divided into two main categories, passive and active]. Passive SMs are those materials that able to transfer some types of energy, e.g. they are used as fiber optic that can transfer electromagnetic wave. Furthermore, active SMs are also divided into two types. The first type are those that can alter their characteristics, when they are exposure to external effects, such as Photochromic glasses that can change its color when it presented in sunshine. The other types can change energy from one form –thermal, chemical, nuclear, mechanical, electrical, and optical- to another form. Solar cells (Photovoltaic cell) and LEDs are two examples that can convert solar energy to electricity and electricity of light, respectively. Likewise, each pyro-electric, piezoelectric and ferroelectric are photovoltaic materials that can generate electricity by energy .

Types of Smart Materials

Piezoelectrics:

Piezoelectric materials convert electrical energy to mechanical energy, and vice versa. They offer a wide range of utility and can be used as actuators (provide a voltage to create motion), sensors, such as many accelerometers, and energy harvesters since the charge generated from motion can be harvested and stored. Common applications for piezo materials are BBQ igniters and actuators for inkjet printer heads.

Shape Memory Alloys:

The most commonly available Shape Memory Alloy is Nitinol, which was originally developed by the Naval Ordinance Laboratory. SMA's have the ability to change phase as a function of temperature, and in that process generate a force or motion. They are capable of relatively high energy but move slowly. Typically applications include morphing structures, thermal triggers, and some high strain energy absorbing applications. Advanced materials still under development include magnetically activated shape memory alloys.

Magnetostrictive:

Similar to piezoelectric materials that respond to changes in electrical fields, this class of materials responds to changes in magnetic fields and can perform as an actuator, or sensor if deformed. While they can work well, they exhibit a large hysteresis which must be compensated when using the material in sensor applications.

Shape Memory Polymers:

Shape Memory Polymers (SMP) are similar to Shape Memory Alloys except the obvious fact they are made from a polymer matrix. They possess much greater recoverable strains than the alloys, but typically under lower forces. Morphing structures has been the area of greatest use to date for SMP's.

Hydrogels:

Hydrogels can be tailored to absorb and hold water, or other liquids, under certain environmental conditions. Hydrogels have been around for a long time, specifically in disposable diapers. A key feature however is the gels can be tailored chemically to respond to different stimuli.

Electroactive Polymers:

There are many forms of electroactive polymers and many are still being refined. They have great potential as the flexibility of how they can be used provide advantages over some of the metals and ceramics mentioned above. Most typically applications include energy harvesting and sensing

Bi-Component Fibers:

Adaptive thermal insulation can enable smart clothing that can change its thermal properties based on the environment.

III. CONCLUSION

With the developments of our technologies, we need to change our traditional material with the material who have smartness and intelligence. Those materials who can response to the external changes and according to that changes can alter their physical and mechanical properties. There are numerous type of smart materials but still lots of research and work is going to be done in the field of these materials to make it familier in all the field. The smart structure is playing excellent role in each filed of science. At present there are numerous filed where smart materials are doing great job i.e. in the field of aeronautics, automotive industries, structural health monitoring , civil engineering, in the field of medical science). Smart materials has vast potential application in every filed.

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